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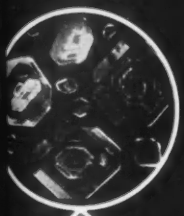

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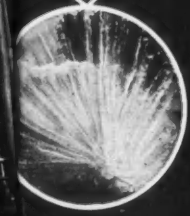

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Editorial:
High Temperature Usefulness
Inside Front Cover

50¢

Thirtieth Year

A SCIENCE SERVICE PUBLICATION

High Temperature Usefulness

▶ THE WHOLE SPREAD of temperature, from cold very close to absolute zero to the almost unimaginable heat of the stellar interiors and hydrogen bomb explosions, is within the domain of chemistry.

With the development of atomic energy, even the older fission sort based on uranium, and the rush of supersonic planes through the stratosphere, high temperatures become a matter of immediate and practical concern. Materials of various sorts, from metals to ceramics, must be tested after they are developed in the hope of being useful at the elevated temperatures in aeronautics and atomics.

The easiest way of attaining the high temperatures needed is to use the cheapest natural source of high temperature, the sun itself. For that reason, solar furnaces are being added to the equipment of research laboratories with the same avidity that cryogenic apparatus has multiplied in recent years. These solar furnaces, described in the leading article of this issue, are but one of the devices that can produce high temperatures.

There are flames that result from the chemical combination of oxygen with acetylene, metals, carbon subnitride, and cyanogen, and hydrogen with fluorine, ranging between 6,000 and 9,000 degrees Fahrenheit. The electrical methods include the high-intensity arc commercially developed to 10,000 degrees F. with flames at 90,000 degrees F. Ballistic pistons rival the chemical flames, while shock waves attain 32,000 degrees F.

Million degree temperatures are reported achieved on a small scale for a fraction of a second in deuterium in a small transparent shock tube, possibly a step to the controlled thermonuclear reaction.

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Including The Science Leaflet

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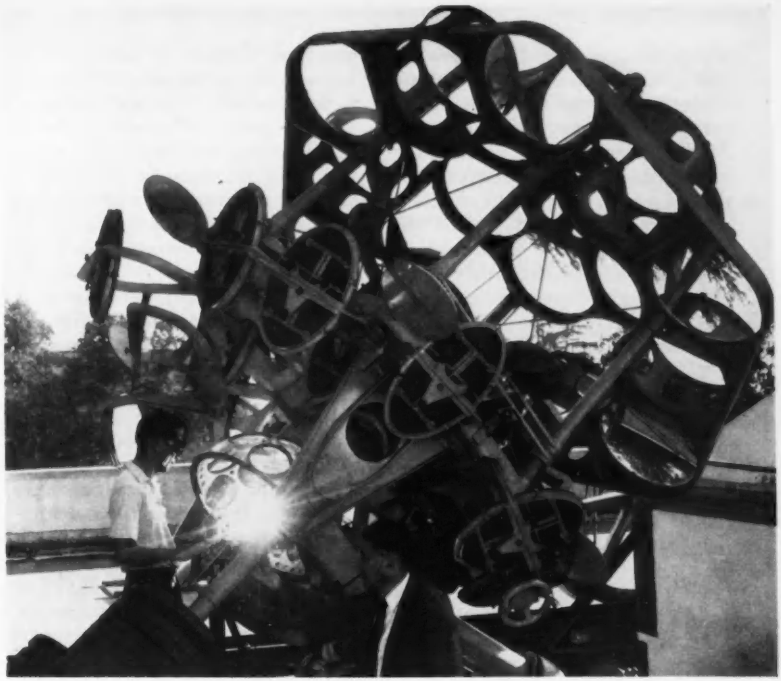


➤ INTENSE HEAT, *without use of fuel or flame, is created in this first of the solar furnaces to be built in the United States. This apparatus is used for high temperature research at the California Institute of Technology.*

Solar Furnaces

By WATSON DAVIS

➤ AT A TIME when nuclear bombs and atomic reactors are considered tops in high heat and energy, scientists are turning to the sun for thousands of degrees of temperature to use in experiments to develop temperature-resisting materials.

The sunshine is concentrated by telescope-like devices to produce heat of more than 6,000 degrees Fahrenheit.

The fuel is free. And the intense heat is produced in an atmosphere free of burning gases, bits of electrodes and other impurities, a decided advantage when the experiments are concerned with materials that have to be kept pure.

Rivaling the heat of electric arcs, hydrogen-oxygen torches and other such sources, solar furnaces are likely to become one of the more usual tools of research laboratories as a relatively

cheap, convenient and safe producer of high heat. A boom in solar furnaces is underway with new ones of various sizes being built or on the drawing boards.

An international conference devoted entirely to solar furnaces held in sunny Phoenix, Ariz., showed that research laboratories, industrial companies, universities and defense agencies are hard at work perfecting the way of bringing the heat of the heavens down to do earthly work.

The United States is to build not far from Alamogordo, N. Mex., near where the first atomic bomb was exploded, the latest and largest of solar furnaces. It is a giant 200-footer to serve the U. S. Air Force in investigations and testing. Only a 200-foot diameter furnace at Mont Louis in the French Pyrenees, built some years ago for the Centre National de la Recherche Scientifique, equals this projected U. S. apparatus. At this French installation there is also an older nest of a large 35-foot and six small five-foot furnaces, while at Bouzareah, near Algiers, is another French solar furnace with a paraboloid of 8.4 meters (28-foot) diameter. This was orginally built for nitrogen fixation, but is now used for research.

Massachusetts Institute of Technology has a medium temperature furnace built several years ago consisting of 400 flat mirrors concentrating on a single target. India's National Physical Laboratory has a similar furnace with 192 mirrors of one square foot each concentrating light on a single foot-square area.

America's first solar furnace is the one built in 1932 at the California Institute of Technology. Instead of parabolic mirrors, it utilizes lenses, because they were left over from the building of Mt. Wilson Observatory. Nineteen lenses of two-foot diameter collect energy over about 57 square feet. Mounted like an astronomical telescope, it rotates to follow the sun.

A number of solar furnaces with openings varying from five to ten feet have been built by William M. Conn of Kansas City, Mo., and some of these, like many of the five-foot units built elsewhere, are made of converted Army searchlights mirrors.

You can find five-foot solar furnaces, most made from searchlights, at Fordham University, Nela Park at Cleveland, Arizona State College, Kennecott Copper Corp., at Salt Lake City, U. S. Bureau of Mines at Morgantown, W. Va., Stanford Research Institute at Menlo Park, Calif., and Convair at San Diego, Calif. Five-foot furnaces have been built also in the USSR, Japan and Australia.

Advances in missiles and atomic power have accelerated the need for knowing what high temperature can do. Missiles heat up when they rush through thin air at supersonic speeds. The fissioning of uranium in reactors produces superheat. The sun is the cheapest and easiest power source for the torrid tests.

Burning Glass Principle

The solar furnace is therefore coming into its own. But its principle is not new. According to an ancient account, Archimedes defended the city of Syracuse by setting fire to the invading navy of Marcellus, using "a burning glass composed of small square mirrors moving every way upon hinges, which when placed in the sun's rays, directed them upon the

Roman fleet, so as to reduce it to ashes at the distance of a bow shot."

Lenses were used to concentrate great heat more than a couple of centuries ago. In 1695 a large burning glass was used to decompose a diamond previously considered unalterable. Metals and other substances that had resisted the heat of the strongest fires were melted with the sun's heat concentrated by large lenses. Lavoisier, the French chemist, in 1774 built a large double-lens furnace and he was nearly able to melt platinum, at a temperature that must have been close to 1,750 degrees Centigrade (3,182 degrees Fahrenheit).

Although it is possible, in theory, to obtain temperatures up to 4,500 degrees Centigrade, various losses cut the practical attained temperature to 3,500 degrees Centigrade, or about 6,300 degrees Fahrenheit. This corresponds to an equilibrium heat flux absorbed by the target of about 1,000 watts per square centimeter, if conduction and convection losses, about one-third of all losses, are disregarded.

The basic principle behind the solar furnace is that the sun's intensity yields from 0.8 to 1.1 kilowatts of energy per square meter at the earth's surface. These figures, rough approximations applying to many parts of the United States, will vary according to the season, altitude, latitude, clearness of the atmosphere and other factors. Gathering this energy and concentrating it at a focal point is the job of the solar furnace.

As the solar furnaces multiply and do more work, there will be better alloys for use in atomic reactors and in jet and rocket engines. At the point where the sunlight is concentrated so effectively in the solar furnace, it is possible to create little "hells" with controlled atmospheres, confined in refractory quartz containers. Out of these bits of sun on earth will come new knowledge for our technologic future.

Solar Heat in Sun or Rain

➤ ONE RESEARCH organization, Arthur D. Little, Inc., Cambridge, Mass., is preparing to put a solar furnace into production. Built around a U. S. Army searchlight, the solar furnace is offered as standard equipment for laboratories conducting high-temperature research. For many programs developing new materials to withstand high temperatures, only a relatively short period of sunshine each day is needed to perform all necessary tests.

But for researchers who want to be free of the vagaries of the weather, it is possible to use this solar furnace without the sun. A high-intensity electric arc can be substituted for sunshine as a source of heat for the Arthur D. Little, Inc., solar furnace, according to a recent report. The temperatures obtained are even higher than the temperatures obtained from sunlight and the heat flux of about 400 calories per square centimeter per second is about the same.

Like its sun-powered counterpart, the new "indoor solar furnace" creates pure high temperatures, without the by-products of ordinary heat sources. Only the radiant energy of the electric arc is used. The samples being studied are isolated from the magnetic field and chemically active atmosphere that surround the arc itself.

Power for the arc can be supplied by a 20-kilowatt generator, using about 20 gallons of gasoline a day.

Tailor-Made Arrangements of Atoms in Long Chains

New Tactics In Polymers

Reprinted from the INDUSTRAL BULLETIN *of Arthur D. Little, Inc.*

➤ CHEMISTS these days are working on some new plastics, described with new words and, what is more important, based on a new concept. The words — "isotactic," "syndyotactic," and "atactic" — were introduced by Professor Giulio Natta, of the Polytechnic Institute of Milan, to describe different arrangements of atoms in certain long-chain molecules. The concept is that these various arrangements can be "tailor-made" for particular uses by the choice of suitable catalysts.

Polymers are very large molecules formed by the joining together of small molecules, called monomers. In the case of polyethylene, the familiar "squeeze-bottle" plastic, the monomer is ethylene, a gas formed by cracking petroleum. Ethylene contains two carbons and four hydrogens, arranged in the following sequence: $CH_2 = CH_2$. But ethylene molecules can be made to unite or "polymerize" to form long chains. A short section of such a chain looks like this:

$$—CH_2—CH_2—CH_2—CH_2—$$

Molecular chains can be more complicated; the building block can be, for example, a "substituted" ethylene monomer of the form $CH_2 = CHR$, where R represents some atom or group of atoms other than hydrogen. (In the case of propylene, the simplest substituted ethylene, R is equivalent to CH_3.) When a substituted ethylene polymerizes, a section of the chain looks something like this:

$$—CH_2—CH(R)—CH_2—CH(R)—$$

However, this structure is an oversimplification, because it does not take into account how the R groups are positioned along the chain. Different arrangements are possible. First, all of the R groups can lie either above or below the main plane of the molecule; this is the *isotactic* arrangement, and represents a highly ordered structure. Second, the R groups can alternate above and below the main plane; this structure, also highly ordered, is called *syndyotactic*. In the *atactic* arrangement, positioning of the R groups is random, and the structure is disordered. According to the new concept, these different arrangements can be achieved by controlling the chemical reaction that produces the polymer, and by choosing the most suitable catalyst, or stimulator, for the reaction.

The effect of spatial arrangement on physical properties is striking. For example, atactic polypropylene is a soft, amorphous, rather gummy substance, but isotactic polypropylene is hard and highly crystalline. The difference arises, apparently, because the highly ordered isotactic chains can pack closely together into a regular crystalline solid arrangement. Further, this close packing means that the isotactic polymer is denser than the atactic form.

At this stage of development, isotactic and atactic polymers have been obtained from simple substituted ethylenes, such as propylene. A syndyotactic polymer has been prepared from a more complicated monomer, butadiene — a building block for synthetic rubber. There has been some talk in trade journals about isotactic polyethylene, but this is really a misnomer; the newer polyethylenes should be called "linear" or "high-density" polymers. However, there is much speculation over possible future competition for polyethylene (the fastest growing plastic) from isotactic polypropylene, which is potentially cheap, and has good physical properties. Both ethylene and propylene are made in huge quantities by the petroleum industry and are used in the production of high octane gasoline. They are also important raw materials for petro-chemicals such as permanent anti-freeze, acetone, and synthetic detergents. Ethylene now sells for about five cents per pound; propylene is even cheaper.

Potential Uses

Isotactic polypropylene (IP for short) is already being made on a pilot plant scale in Italy, and a number of American companies are studying its potential. It appears to be twice as strong as, and more rigid than ordinary polyethylene, and has about the same tensile strength as the new high-density polyethylenes. Also, its melting point is even higher than that of the linear polyethylenes, 320° F vs. 250-270° F. In view of its properties, IP is expected to enter the same end-use markets as the various polyethylenes: film, moldings, pipe, plastic bottles, and wire and cable insulation.

Another potential use is as a synthetic fiber. Stretched IP fibers are reported to be even stronger than nylon fibers, but here the relatively low melting point may be a limitation; for comparison, the melting point of nylon is in the range 415-480° F. Another limitation of IP for apparel fabrics is low water absorption, which means that it will readily accumulate a static electrical charge, and therefore attract dust and lint. This limitation, however, applies to most synthetic fibers, and it may be minimized by blending with water-absorbing natural fibers such as cotton or wool. Potential non-apparel uses of IP fibers include rope, industrial filter cloths, and seat-cover and upholstery fabrics.

Although polypropylene will probably be the first commercial isotactic polymer, the general concept of tailor-making complex plastics may be more important in the long run. With the concept well established, polymer chemists are busy attempting to understand the mechanism of the reactions and applying the technique to other possible monomer-catalyst systems. Further discoveries of scientific interest and further improved plastics are inevitable.

One of the important phenomena to be measured from an earth satellite is the sun's ultraviolet and X-ray radiation, normally hidden by the atmosphere.

Adding fungicidal acids to tung-oil paints may make it possible to produce surface coatings with built-in mold and fungi resistance.

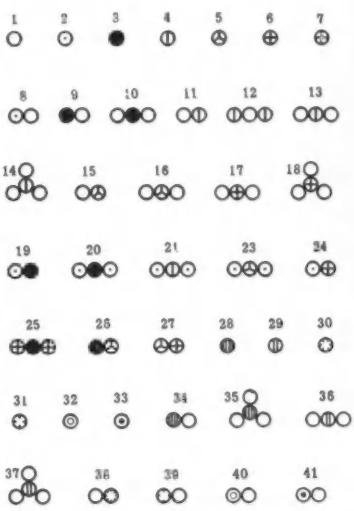
Berzelius Invented Present-Day System of Chemical Symbols

A Page From the Past

Reprinted from THE BRANCHED CHAIN, *published by the East Tennessee Section of The American Chemical Society, J. F. Eastham, editor, Knoxville, Tennessee.*

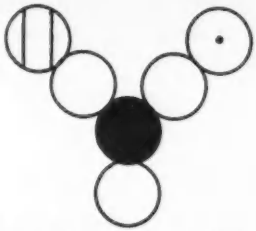
➤ THE FOLLOWING article appeared in January, 1814, in the *Proceedings of the Manchester Philosophical Society*. It was written by J. J. Berzelius and is a good example of the many practical contributions which this scholar made to the science of chemistry. Berzelius is, of course, well known for his fundamental contributions to chemistry and its theories — for his considerable aid in explaining and developing the atomic theory, and for the discovery of numerous elements. His contributions to the practical aspects of chemistry are not so well known but probably as important.* The practical importance of his development of our system of nomenclature would be hard to overestimate. Linguists tell us that the development of certain cultures has been limited by their language or system of symbols. It is logical to expect that sciences could be limited in a similar manner.

It would be hard to imagine our science developing as rapidly as it did in the nineteenth century if Dalton's symbolism had been retained. Dalton's symbols for the elements are shown. How the symbols were employed to represent a compound is illustrated with sodium bicarbonate. Dalton himself was one of the last to recognize the advantages of the Berzelius system. Long after this system had been proposed, Dalton is reported to have said, "Berzelius' symbols are horrifying. A young student might as soon learn Hebrew as make himself acquainted with them."



➤ SYMBOLISM CIRCA *1810. 1. Oxygen. 2. Hydrogen. 3. Carbon. 4. Nitrogen. 5. Phosphorous. 6. Sulphur. 8. Water. 10. Carbonic Acid. 18. Sulfuric Acid. 26. Potassium. 29. Sodium.*

* The practical ability that was possessed by Berzelius is also revealed in his laboratory innovations and accomplishments. For example, he introduced the blow pipe for mineral analysis, rubber tubing, and filter paper. His values determined for atomic weights, before most chemists admitted the reality of atoms, are remarkably close to present-day values.



➤ Sodium Bicarbonate *á la Dalton.*

Other of Berzelius' contributions were not so broad in scope as the nomenclature system. Many have become most important, however, in a similar semantic sense. Thus, in 1832, he wrote:

> Recent researches have now shown that the absolute, as well as the relative, numbers of elementary atoms may be the same, their combination taking place in such a dissimilar way that the properties of equally composed bodies may be different . . . Since it is necessary for specific ideas to have definite and consequently as far as possible selected terms, I have proposed to call substances of similar composition and dissimilar properties *isomeric* . . .

Berzelius thus was the first to clearly recognize isomerism. He fully defined the phenomenon and gave us the term which describes it. Again in 1836 Berzelius wrote:

> It is, then, proved that several simple or compound bodies, soluble and insoluble, have the property of exercising on other bodies an action very different from chemical affinity. By means of this action they produce in these bodies decomposition of their elements and different recombinations of the same elements, to which they remain strangers. This new force, which was unknown until now, is common to organic and inorganic nature. I do not believe that it is a force entirely independent of the electrochemical affinities of matter; I believe, on the contrary, that it is only a new manifestation, but since we cannot see this connection and mutual dependence, it will be easier to designate it by a separate name. I will call this force *catalytic force*. Similarly I will call the decomposition of bodies by this force *catalysis*, as one designates the decomposition of bodies by chemical affinity *analysis*.

This was the first recognition and description of the concept of catalysis.

On the Chemical Signs and the Method of Employing Them to Express Chemical Proportions

by Jacob Berzelius, *M. D., F.R.S., Professor of Chemistry at Stockholm*

When we endeavor to express chemical proportions, we find the necessity of chemical signs. Chemistry has always possessed them, though hitherto they have been of very little utility. They owed their origin, no doubt, to the mysterious relation supposed by the alchymists to exist between the metals and the planets, and to the desire which they had of expressing themselves in a manner incomprehensible to the public. The fellow-labourers in the anti-phlogistic revolution published new signs founded on a reasonable principle, the object of which was, that the signs, like the new names, should be definitions of the composition of the substances, and that they should be more easily written than the names of the substances themselves. But, though we must acknowledge that these signs

were very well contrived, and very ingenious, they were of no use; because it is easier to write an abbreviated word than to draw a figure, which has but little analogy with letters, and which, to be legible, must be made of a larger size than our ordinary writing. In proposing new chemical signs, I shall endeavor to avoid the inconveniences which rendered the old ones of little utility. I must observe here that the object of the new signs is not that, like the old ones, they should be employed to label vessels in the laboratory: they are destined solely to facilitate the expression of chemical proportions, and to enable us to indicate, without long perophrases, the relative number of volumes of the different constituents contained in each compound body. By determining the weight of the elementary volumes, these figures will enable us to express the numeric result of an anlysis as simply, and in a manner as easily remembered, as the algebraic formulas in mechanical philosophy.

The chemical signs ought to be letters, for the greater facility of writing, and not to disfigure a printed book. Though this last circumstance may not appear of any great importance, it ought to be avoided whenever it can be done. I shall take, therefore, for the chemical sign, *the initial letter of the Latin name of each elementary substance*: but as several have the same initial letter, I shall distinguish them in the following manner: — 1. In the class which I call *metalloids,* I shall employ the initial letter only, even when this letter is common to the metalloid and to some metal. 2. In the class of metals, I shall distinguish those that have the same initials with another metal, or a metalloid, by writing the first two letters of the word. 3. If the first two letters be common to two metals, I shall, in that case, add to the initial letter the first consonant which they have not in common: for example, S=sulphur, Si=silicium, St=stibium (antimony), Sn=stannum (tin), C=carbonicum, Co=cobaltum (cobalt), Cu=cuprum (copper), O=oxygen, Os=osmium, etc.

The chemical sign expresses always one volume of the substance. When it is necessary to indicate several volumes, it is done by adding the number of volumes: for example, the *oxidum cuprosum* (protoxide of copper) is composed of a volume of oxygen and a volume of metal; therefore its sign is Cu + O. The *oxidum cupricum* (peroxide of copper) is composed of 1 volume of metal and 2 volumes of oxygen; therefore its sign is Cu + 2 O. In like manner, the sign for sulphuric acid is S + 3 O; for carbonic acid, C + 2 O; for water, 2 H + O, etc.

It is predicted that new bombardment processes will lead to new plastics tough enough for automobile bodies, aircraft and building parts.

The source of the sun's warmth and light is much the same fusion process that is utilized in the hydrogen bomb.

Before the present Near East situation arose, nearly 1,500,000 barrels of oil were passing through the Suez Canal daily.

Head of Leading Chemical Concern Looks To Future

The American Chemical Industry

by CHARLES ALLEN THOMAS, *President, Monsanto Chemical Company*
An address before the New York Group, Investment Bankers Association of America.

➤ SOME months ago, millions of us Americans who are "sidewalk superintendents" took front row seats in front of our television sets and watched with a kind of grim fascination as a large steel ball smashed the walls of Marshall Field's home in Chicago to dust. The cameras might just as easily have focused on your city or mine, for all over this country of our's today, landmarks are falling to make room for tiered parking lots and towers of aluminum and glass.

Regardless of what one thinks of this trend, I believe we can agree that a determination to break with the past is a characteristic inherited from our ancestors all of whom turned their backs on the shores of the Old World in order to conquer a new one. For a long time, then, we were so busy making history that we did not have time to study it, with the result that today a great many of us do not have the strong ties and appreciation of the past which enrich the traditions of some of the other peoples.

Our Chemical History

We chemists are particularly aware of this state of affairs for this year we are celebrating a centennial anniversary of a discovery responsible for the development of modern drugs, plastics, synthetic fibers, and a variety of equally important, if less familiar things — but I'll wager that more people know Mickey Mantle's batting average than know the name of the man to whom we owe so much. It's true, of course, that he was recently honored by the American Association of Textile Chemists and Colorists, and that's understandable because he invented the first synthetic dye of real industrial importance. But with the exception of this group and delegates from other technical societies represented at the event, there aren't many in this country who realize the debt of gratitude we all owe to a British teenaged chemist, William Henry Perkin, who made a violet dye from coal tar while home on Easter vacation in 1856, and thereby laid the foundation of what we call today our modern synthetic organic chemical industry.

The Coal Tar Chemicals

Perkin's "mauve" paved the way for the discovery of a vast assortment of artificial colors which ended nature's monopoly of the rainbow tints obtained from roots, bark, and berries, and led to a rapid growth of interest in the whole field of organic chemistry. Out of this development,

came the realization that coal tar, in addition to supplying building blocks for dyestuffs, could be made to yield about a dozen primary products which chemists have been busy ever since converting into thousands of compounds which help us sustain life and support our economy.

So important are these organic compounds — they annually represent about 21 per cent of the chemical industry's total sales — that modern-day scientists have sought to find new ways of making these essentials. In the United States, the search has resulted in the pioneering development of petroleum and natural gas as basic sources for chemical raw materials. Output of petrochemicals in this country jumped from 75 tons in 1925 to over 15 million tons last year, and predictions are that the growth curve will continue to skyrocket. At present, about 25 per cent of all chemicals made in the United States are derived from oil and gas, and within the next ten years, the figure is expected to jump to about 50 per cent.

Growth Since World War I

That this advance should have been made in this country is truly amazing when you consider that the American synthetic organic chemical industry did not come of age until the First World War. Up until that time, the leaders in our country, like those in Britain and France, were content to watch apathetically as Germany developed into the coal-tar capital of the world.

At last in 1914 our nation woke up to the fact that "the same plant that converts the benzene and the toluene, the aniline and the toluidin of the coal tar into flaming colors or into the paint-soothing or disease-curing medicinals" are ready to "convert in war time these crude products into the all powerful T.N.T., picric acid and similar weapons of war."

Out of this experience emerged this country's organic chemical industry which we know today — with sales in 1955 of $5,600,000,000. These statistics do not include tars and crudes.

The Inorganics Industry

As large and important as it is, however, the organic chemical industry is only one branch of the giant chemical industry. Its distinguishing characteristic is the fact that all the compounds included in this category contain a carbon atom, in contrast to inorganic chemicals, the other great segment of the industry, which are largely derived from minerals and atmospheric gases. Included in the latter group are such familiar substances as soda, sulfuric acid, and some of its salts, alum and ammonia.

To manufacture several inorganic products, John Winthrop Jr. set up a chemical plant outside of Boston in 1635. The processes he used, however, can be traced back to the time of the Pyramids and were largely "rule-of-thumb" because the great principles of chemistry were yet to be discovered. The big break-through came in the eighteenth century when a coterie of brilliant pioneers, spearheaded by the genius, Lavoisier, substituted concrete axioms for the misty concepts of the alchemists, and firmly established chemistry as a distinct science. Until their discoveries, a chemical historian has pointed out, "there was no chemistry in the scientific sense,

and there was no chemical industry as we know it."

The Leblanc Process

The joint development of the two began in 1791 when Nicholas Leblanc worked out a method for making sodium carbonate from salt. Unlike contemporaries of his time, his interest in perfecting this process was not merely to prove a theory, but to earn some money, and it is precisely because Leblanc had one eye on chemistry and the other on economics that he is remembered today as the father of industrial chemistry. His aim — to make something into something else by scientific means for commercial application — is the foundation upon which the entire structure of the chemical industry has been built. Leblanc's achievement, which has been called the "most important industrial chemical process of the nineteenth century" provided the world with a cheap new source of alkali which was first used by the French glassmakers.

Later transplanted to England, the Leblanc process inevitably led the alkali producers into the manufacture of sulfuric acid, hydrochloric acid, and a variety of other "heavy chemicals" which revolutionized the soap and textile industries and resulted in the establishment of a powerful inorganic chemical industry in Britain.

So efficient and well-organized were these alkali makers that the United States relied on them for its supply of soda products until about 1885. This does not mean, however, that there was a total absence of chemical manufacturing in this country during the nineteenth century. Quite the contrary! In fact, it is estimated that as early as 1830 there were at least thirty different chemical manufacturing firms in the United States, with a total sales in excess of a million dollars a year. Like their British competitors, however, these companies were primarily concerned with the production of "inorganics" even after Perkin made his momentous discovery, which is one of the reasons why Germany was able to dominate the organic chemical market for so many years.

Early Expansion Slow

Those of you whose grandfathers were in the investment banking business a century ago, however, would never have come together as you have done this evening to hear a chemical businessman speak, for in those days our world was as far removed from yours as Mars from the Earth. In fact, until the First World War as FORTUNE has pointed out: "The expansion of the chemical industry was slow enough to be financed out of earnings. And bankers had barely heard of chemists."

Somehow even during the Gay Nineties when the great trusts were being put together, chemical manufacturing remained in the "hands of comparatively small, independent enterprisers." Even today's giants, like duPont, Union Carbide, Allied, Monsanto and Dow were yet to be listed on the New York Stock Exchange as late as January, 1920, a year which is important to our industry because it marked the beginning of a decade which saw some 500 mergers completed among chemical companies. A few combinations had been made earlier, but the roaring twenties

marked the first big merger movement in our industry. Expansion, however, was characterized by a very different pattern from that of Europe where great cartels monopolized particular segments of the chemical industry. In this country, instead, the trend was toward diversification with individual companies in time becoming sort of chemical cafeterias offering everything from tank cars of chlorine to milligrams of cortisone.

Diversity Is Necessary

To the uninformed this may seem illogical, and perhaps uneconomical, but to those who understand the complex personality of the chemical industry — this growth pattern makes sense. For versatility is as natural and as necessary to chemical manufacturing as the basic raw materials — coal, salt, limestone, sulfur, air, water and oil — which it uses. Because of this, it is virtually impossible for us to make only one product from a single process — instead, we nearly always wind up with an assortment of what our forebears called by-products. "It is," as the late Arthur D. Little commented, "as though a cotton mill, to make thirty-five yards of cloth, was forced also to turn out forty shoes."

Research Pays Off

To find uses for all of these so-called "extras" is frequently a great challenge, for unfortunately, product application ideas do not spring full-blown from our brains like Athene from Zeus' head, but are usually the result of patient and rewarding research. And this explains why the average chemical company is putting at least three per cent of its sales dollar into this item, and why our industry is reported to have spent over $360 million on what we call R and D (Research and Development) in one year according to a survey made by the National Science Foundation.

This is the price we pay for progress, as someone has said, and when we consider the results of the investment — I'd say that it has paid off — and handsomely. Consider Monsanto, for example. From 1950 through 1955 we spent a little over sixty million dollars on research and development — an expenditure which resulted in the introduction of 173 NEW products. (Incidentally, for your information, this sixty million total does not include any patent work or engineering costs — items, which I understand, some companies regularly add in when releasing figures on their research and development efforts. Consequently, it is impossible for me to compare our expenditure with those of our competitors, since nearly all of us use different accounting methods.)

A New Product Is Born

Now, I'm going to tell you about one of our newest products, developed in cooperation with Esso Research and Engineering Company. This joint research effort, by the way, is a typical example of the way chemical companies often step across industrial boundary lines to work with other concerns on problems which are of mutual interest.

Trademarked Elastopar, it is the first commercially practical chemical modifier to be developed for butyl rubber. To visualize the significance of this new product, let us consider for a moment one of the newest applications for butyl — automotive

tires. The reported advantages of butyl as a tire building material — softer, quieter rides, better braking, freedom from squeal, to mention a few — were known many years ago, but incorporating these features into commercial tires brought up an obstacle which at first appeared insurmountable. Butyl developed too much heat as the tire absorbed road shock.

Eventually, it was found that the butyl polymer could be modified by chemical treatment to avoid this discouraging heat build up, but a practical means of doing this did not exist. The first method of modification required unusually high processing temperatures and long mixing times in order to be effective. It was at this point that Monsanto entered the picture to perfect a chemical which would provide all the benefits of the long heat treatment but do it during a normal mixing cycle.

The result is Elastopar, which approximately doubles the resilience and strength under strain of unmodified butyl rubber and does this in the course of conventional processing steps. This means that butyl tires with their comfort and safety advantages now can be produced with practical production techniques and their commercial availability becomes immediately possible.

The improved resilience or rubberiness of Elastopar-modified butyl is expected to hasten acceptance in a number of other areas such as hose, electrical insulation, and air springs.

Other New Chemicals

In the meantime, improvements in GR-S are in the offing and each product undoubtedly will find its respective place in an enlarged market. We hope to continue to supply chemicals for both. Indeed, this is so typical of the mobility so necessary in the chemical industry, an industry which now spews out new products at the rate of one a day. Such a statement sounds Jules Verne-ish but when you recall that chemicals introduced since 1939 accounted for 20 per cent of the Federal Reserve Board production index of chemicals and allied products in 1953 — it becomes much more understandable.

But even the figures don't tell the whole story. You have to remember what life was like at the end of the thirties to grasp the changes that have taken place. Shampoos came in glass containers then — there weren't any squeeze bottles; dandelions on the front lawn still had to be pulled up by hand or dug out with a hoe — 2,4-D was not yet available; Dynel, Acrilan, Orlon and Dacron had not yet been spun; titanium was just a name in the textbooks; penicillin was yet to be produced commercially; and the heavy-duty synthetic detergents had still not joined the clean-up parade. All of you here, I am sure, could add other products to this list — but these are enough to suggest why chemistry is nearly as creative as Mother Nature herself.

Low-Cost Processes

Producing these new products is, of course, one of our fundamental goals, but it is not our only purpose in putting some of the best of our technical talent behind the laboratory bench. Another equally important aim is to improve our processes for making old favorites, in order to produce cheaper and better chemicals. That we have been successful, I think,

is indicated by statistics which show that with one important exception — electric power — the wholesale price index of industrial chemicals over the past quarter century has risen less than any other major commodity group. As I have indicated, the credit for this record belongs, I think, to the research and engineering people who have been striving for decades now to perfect processes and reduce costs. Out of their efforts have come some important price reductions. Acetone, for example, which sold for 21 cents a pound in 1920 now costs eight cents a pound. Liquid chlorine now sells for a little over three cents a pound; in 1920 it cost eight cents a pound. And polystyrene, which can now be bought for a little over 27 cents a pound, cost 85 cents a pound when it was first produced commercially in the United States back in 1937. And all this in spite of inflation.

Chemical Sales Increase

Facts like these help to explain why the sales of the chemical industry have increased more than five fold since 1939, reaching a record high of more than $23 billion last year, according to the government classification of our industry. Substantial though this figure is, it does not represent the *total* sales of our industry which, in a sense, is like a giant centipede with a foot in a great many industries not included under the standard industrial classification. For instance, it does not include the chemical sales of the oil companies nor the resins sales of the rubber companies, nor the sales of some of the less common metals, such as titanium or zirconium, which are produced through chemical processes, but in many instances, by companies not in the chemical industry. (The Crane Company's production of titanium is an example.) If all of these were added into the chemical industry's sales, I suspect that the figure of 23 billion dollars would be substantially increased.

Actually, each day it becomes more and more evident that "a chemical process is involved to one extent or another in all manufacturing operations that are not limited strictly to mechanical fabrication."

Adding to the difficulties of defining our industry with precision is the fact that it doesn't stay put; it is constantly spreading and spawning into all industrial activities. For example, a steamship company is now an important chemical producer; a chemical company currently is a major metal producer; most of the large oil companies are in the chemical business; and last year another chemical manufacturer went into the oil business.

One thing is clear, however, and that is that we are going to spend a record amount, one billion, four hundred thirty-three million dollars, to expand capacity this year, and 1957 should be even larger with over one billion, five hundred seventy-six million dollars worth of new capacity slated for construction. In announcing these plans, we're following in our own footsteps — in *each* of the past four years the chemical industry has invested more than a billion dollars in new plants.

The Chemical Future

Now, what of the future? Has our industry reached its maturity and

levelling-off? We think not. Recently, some chemists and engineers spent some time with me, peering into the crystal-ball in an effort to give you a sort of sneak preview of the future. Unfortunately, scientists aren't as gifted as Merlin — or even Winchell — when it comes to making predictions — but we do enjoy catching a comet by the tail, catapulting off into space, and sort of floating around on the wings of our imagination, catching glimpses of what's around the chemical corner. And, here's what we see ahead.

To some of you, what I'm about to say may sound as if we had all been reading too much Buck Rogers — but when you compare the so-called "good old days" at the turn of the century with life in these mid-fifties, and consider all the changes which science and technology have wrought — then these thoughts about the future become a lot less fantastic. Indeed, unless we are able to make some of these dreams come true, I fear we shall not be able to keep pace with the stork who is reported to be depositing babies on our doorsteps at the rate of more than seven a minute.

Fresh Water From Salt

Already, for example, we face a water shortage, brought on *in part* by this booming birth-rate plus a number of other complicated factors — with the result that in some parts of the United States the lowering of the water table is even now a matter of concern. And this is why, I expect, so many scientists these days are trying to find a cheap and practical way for converting salt water into fresh water.

So far, we have attacked the problem from a number of different angles, but unfortunately, nobody yet has figured a way to pump water from the sea, and remove the salt by a process which is economically practical on a large-scale, for say, irrigation purposes. We are able to do this in a small way, as you know, through the use of base-exchange resins which are responsible for the success of the device which those cast adrift in the ocean now use to secure fresh water.

But the operation of these interesting resins requires some form of energy — a regenerating energy which costs money. That is why, so far, we haven't been able to use them in very large-scale commercial operations. Maybe the answer will come when we discover a new type of base-exchange resin which can be renewed by those plentiful and powerful light particles sent to us by the sun — those particles that today energize the new solar batteries of telephones and radios.

To solve this pressing technological problem perhaps we should attempt to copy Mother Nature who uses a most ingenious low energy system for demineralizing water — utilizing one of the most marvelous organs of all — the human kidney. One of the secrets of her success is that she is able to do this work with relatively little effort (she uses only a small amount of energy to do the job.) And that's what we must learn to do, if we are ever to make the sea a reservoir capable of turning deserts into fertile fields.

Power From The Sun

Helping us to increase our water supply, however, is only one of the ways in which I think the sun will

be able to aid us in the future. We must, I think, learn how to harness its enormous power — that daily floods the earth with several thousand times more energy than man consumes. All this is not so far-fetched when you consider that in a hundred years, perhaps fifty, some experts predict that the United States may find it necessary to heat and cool some of its homes, and run some of its factories, by solar methods — in order to conserve atomic power and fossil fuels. These predictions make sense too, when you recall that fuel needs for 2055, as projected, are expected to dwarf the entire energy requirements of the United States today.

With this in mind, scientists are actively working on devices which can convert photons (particles of light) into useful energy. Those of us in the chemical industry are vitally interested in this project, because ultimately this would mean that the price of the kilowatt would come down, enabling us to produce chemicals by electric furnace operations or by electrolysis, instead of relying on conventional fuels to supply us with the heat we need to produce our reactions.

Atomic Power

Another source of energy expected to grow in importance in the years ahead is, of course, atomic power. It's estimated that by 1980, 100 million kilowatts of power will be generated from atomic energy. In addition to lighting our homes and turning the wheels of our factories, however — it's predicted that all naval ships started after 1960 will be nuclear powered.

This is just one of the changes foreseen in transportation, however. On land it's expected that another invention, the development of the turbine or free piston engine for automobiles will bring about revolutionary changes. Its introduction will, I predict, have widespread repercussions in both the oil and chemical industries, resulting in the production of entirely different types of fuels and lubricants — some of them, perhaps, completely synthetic.

Plastic Building Materials

Also coming — if we prognosticators are right — are far-reaching alterations in another vital segment of our lives — shelter. In fact, we visualize two different types of houses — permanent and transient. Both will make increasing use of plastics — which we feel are just now beginning to come into their own as important building materials — some half-billion dollars worth went into construction last year.

Right now, they are being widely used as interior surfaces, for floor and wall tile, in skylights, translucent roofing, electrical devices, insulation, and indoor paints. Other outlets — catching on fast — are in pipe, hardware, luminous ceilings, and light fixtures. Visualized for the future are great synthetic domes covering both house and garden and bringing push-button controlled climate; plastic plumbing fixtures; and molded bathrooms which can be shipped in relatively small, lightweight twelve-piece packages.

Some of these ideas will be demonstrated in the "House of Tomorrow" designed at the Massachusetts

Institute of Technology under the sponsorship of Monsanto — and soon to be erected at Disneyland. This house will be practically 100 per cent plastic.

Inorganic Polymers

Great strides have been made in the field of synthetic polymers since Leo Baekeland demonstrated his first all test-tube resin back in 1909 — but, as you know, all of these developments make use of *organic* materials. Today, however, we in the chemical industry are looking forward to discovering how to make synthetic *inorganic* polymers — an area, which at the present time, is in about the same stage of development as Antarctica. Potentially, I think, it will provide a whole new field for industrial enterprise — if only our explorers are successful in penetrating the many unknowns. For example, it seems reasonable to expect that out of this research will come new types of cements from which artificial stones can be made, materials rivaling the beauty and durability of the finest polished granites and marbles. In some cases, we may even be able to make polymers which will resemble jewels. From the laboratories will come solutions which, when mixed together at the construction site, will polymerize enabling us to make all sorts of tailor-made rocks especially created to do specific jobs. Out of these efforts will emerge, I think, a new type of enlightened "Stone Age," with man fabricating materials which will, in time, be used in place of many of our present-day building blocks.

As their investigations continue, I believe we shall discover products which we can inject into soils and sands to make them hard and impenetrable. Thus, we shall be able to build roads by simply "shooting" special formulae into the ground. Moreover, I foresee the time when we can apply this same principal to tunnels, oil and gas pipes, reservoirs and dams — making it possible for us to eliminate the lining of excavations — for we would simply harden the earth with chemicals. If I'm right, then, of course, foundations for homes and basements could be prepared with ease and rapidity.

No More Nails

Also just over the horizon are new types of adhesives which can be squeezed out of a tube like toothpaste and foamed into place in less time than it takes the "Do It Yourself" enthusiast to drop a hammer on his toe. Just as we bind some shoes and aircraft parts together today without nails or rivets, so we shall be able, one day, to seal structural layers to one another with the new chemical adhesives. The resulting bond will be, if our assumptions are correct, as strong as the materials which we have joined together. When that day comes the nail will be as antiquated as the buggy-whip.

Automation and Chemistry

Another scientific frontier — one of the most challenging of all — lies in the realm of what we call, for lack of a better name, solid-state physics. Actually, this isn't a very accurate appellation, for in one sense as the Wall Street Journal commented — "solid state physics can be described as a combination of chemistry and electronics." Actually, what scientists are trying to do is learn more about

the basic nature of matter, in order that we can understand what goes on when corrosion, combustion and catalysis take place.

Much of the knowledge gleaned from this work will further the introduction of automation into the chemical industry — an innovation which, I believe, will be of tremendous significance in our business for two reasons. In the first place, it will require us to learn more about the fundamentals of the reactions which we have been carrying on for years. For, difficult as it is to believe, right now the kinetics involved in some of the processes which we have been using for decades are still unknown. In a sense then, the coming of the electronic tube to our industry will force us to do something which we have never taken the time to do — namely, to dig more deeply into the mysteries of chemical mechanics.

Once we understand more about the rates and mechanisms of our reactions, we shall be able to "automate" our industry, I think, and achieve an environment which will enable us to obtain maximum yields of the desired products. This, in turn, should help us, in the second place, to reduce the costs of our operations because once we fully comprehend the fundamentals of our reactions and are able to "automate" our plants, we shall be able to increase the productivity of our labor by raising the level of its skill.

There are, of course, many other developments which I have not touched on, but I'll save those for another speech. Otherwise, I fear that you will still be sitting here listening to me, while that future, which I have been talking about so confidently, passes us all right by. I think I have said enough, however, to indicate that I believe the chemical industry is going to keep right on growing — just like Jack's beanstalk.

To realize all of these potentialities, however, will, as you are fully aware, take money. Those of us in the chemical industry hope to generate as much capital as possible out of our earnings, which is one of the reasons why, I predict, chemical company stocks will continue to be purchased for their growth, rather than for their dividend rate. But should these developments which I have been discussing reach fruition more quickly than we anticipate, then it will be necessary for the industry to seek some outside financing.

Irradiated Cotton Research

➤ SCIENTISTS are learning whether cotton, like some foods, can be improved by irradiation.

Massachusetts Institute of Technology researchers working under contract with U. S. Department of Agriculture scientists are exposing cotton fiber, yarn and fabric to high-energy radiation generated electrically or by radioisotopes.

The investigators will discover whether radiation helps or harms chemical treatment of cotton. They will find out how much radiation can be absorbed by fibers, yarns and fabrics without sacrificing strength, elasticity, resilience or affinity for dyes. They will attempt to make some fabrics more durable with radiation.

H-Bomb Reactions Occur at Time of Northern Lights

Reactions High in Earth's Atmosphere

➤ H-BOMB REACTIONS occur high in the earth's atmosphere at the time of northern lights or auroras. The reactions are not caused by fallout from hydrogen bomb tests but by tiny charged particles hurled earthward by the sun.

Studying the high level thermonuclear reactions would be a new method for learning about auroras, Dr. S. Fred Singer of the University of Maryland suggests. He reports plans to use, about the first of next year, an especially equipped airplane flying near 50,000 feet to try to detect the solar-caused effects.

An earth-circling satellite coated with one of the light elements could also be used to spot the effects, Dr. Singer says.

He believes the "most important" of the reactions is the capture of protons by nitrogen in the upper atmosphere, releasing large amounts of energy. Very high speed particles, particularly protons, thrown out by the sun cause a "relatively small" number of thermonuclear reactions, he proposes. They also are believed to cause the shimmering displays of auroral color and ionization of the atmosphere at high altitudes.

Penetrating gamma rays produced by the capture of protons by nitrogen indicate the nature and energy of the incoming particles. These nuclear effects must be considered in designing space satellites, Dr. Singer says. If gamma ray production is undesirable, the satellite's surface should be coated with an element of relatively high atomic number.

On the other hand, by using two Geiger counters, one coated with one of the light elements and the other uncoated, detectors for solar protons of the desired energy can be constructed, even though low-energy protons alone could not penetrate the rocket wall.

Photochemical Reactions

➤ THE NIGHT SKY'S faint glow is due to a process involving sodium vapor, a first-of-its-kind experiment at Holloman Air Development Center, Alamagordo, N. M., has shown.

By throwing sodium vapor from a high-flying rocket, scientists of the Air Research and Development Command verified that the night glow not caused by moonlight and starlight is due to photochemical reactions in the upper air. Sensitive instruments can detect the nighttime glow characteristic of sodium.

Previous rocket flights have been used to study sodium behavior at twilight. Then the sodium vapor, ejected from a rocket at high altitudes, was still in the direct rays of the sun. This flight, however, was made at night.

When the rocket reached an altitude of 30 miles, the sodium vapor was released, and the ejection continued until the rocket had reached a peak of 85 miles and returned to 45 miles above the earth. Four pounds

XUM

of sodium were distributed along the rocket's trajectory.

The chemical caused a yellow trail clearly visible to the eye in the region from 30 to 60 miles high in both the upward and downward path of the rocket. Above 60 miles, there was no visual effect.

Soldering Unsolderable Materials

➤ AN UNUSUAL new technique which permits soldering such materials as aluminum, stainless steel, glass, and ceramics without special equipment has been developed by the University of California's Los Alamos Scientific Laboratory. The method is expected to affect great savings over the ultrasonic method and to be of particular interest to aircraft and electronics industries, home-workshop hobbyists, and laboratory equipment makers.

The new method of joining materials hitherto believed impossible to solder was developed by Joseph C. McGuire of the Laboratory's Chemistry and Metallurgy Division. It requires, in addition to the usual soldering materials, only a hand grinder with an abrasive wheel. The technique was discovered by McGuire during a research project on the use of ultra-high-frequency sound waves in soldering, and ironically involves doing something that apprentice mechanics are taught not to do.

To solder these previously unsolderable materials, the grinder is turned on and the abrasive wheel (preferably preheated by grinding metal or by the use of heat) is brought to bear on a soft solder such as Wood's metal or 60-40 lead-tin. The soft solder melts and flows onto the surface of the wheel, "loading" it and incidentally making it useless for its customary purpose until it has been trimmed down. The solder-loaded wheel is then applied to the surface to be soldered until a slight amount of abrasion has taken place, using the pressure one would ordinarily use in grinding. The heat of friction again melts the soft solder, which flows onto the freshly abraded surface and forms an intimate contact.

After this tinning operation, soldering is done in the usual manner with standard 50-50 lead-tin solder. The other surface is also given the new treatment if it is a material not ordinarily "wetted" by solder. No soldering flux, surface cleaning, or pretreatment is used.

When working with such materials as soft glass, Pyrex, and ceramics, the best tinning is accomplished with a mixture of Wood's metal and 50-50 indium-tin. However, when soldering glass to glass or ceramic to ceramic, it is necessary to use flame or furnace heating to get enough heat to the surfaces to be joined.

The two surfaces need not be of the same material: metals, soft glass, Pyrex, and ceramics may be soldered in any combination. A satisfactory grinding wheel has been found to be a medium grit, ¼-inch diameter by ½-inch long, although the type and size are not critical.

Cultivates Higher Plant Tissue as Single Cells

New Biochemical Tool

➤ A WAY has been found to cultivate higher plant tissues as single cells by Dr. Louis G. Nickell of Chas. Pfizer & Co., Inc., Brooklyn, N. Y. Its development may prove to be one of science's most important tools for finding a chemical cure for cancer, as well as opening new investigations of the "basic machinery" of the plant cell.

Sought after since the turn of the century as one of the great challenges to biological science, the Nickell method is reported in a recent *Proceedings* of the National Academy of Sciences.

What Dr. Nickell and his Pfizer co-workers have succeeded in doing, is to propagate whole populations of separated, individual pole bean plant cells in a synthetic liquid of coconut milk and the deadly weed killer 2, 4-D.

This new method for growing single plant cells in the laboratory has these advantages for science, particularly in the fight against cancer:

1. It now permits scientists to manipulate the cells of higher plant life in a way in which it was only possible to manipulate microrganisms and animal cells in the past.

2. In most cases, every ingredient a plant cell needs for growing is known, thus allowing the determination of the exact effect on a plant cell of any chemical chosen to be added to the medium.

3. Plants develop many kinds of tumors, representing all the major types of cancers found in animals. How the plant responds to chemical agents developed to fight the tumors can now be gauged.

4. Plants also grow hereditary, virus, bacteria, and chemically-induced tumors, and still others of unknown origin. These can now be studied and chemotherapeutic agents tried on them.

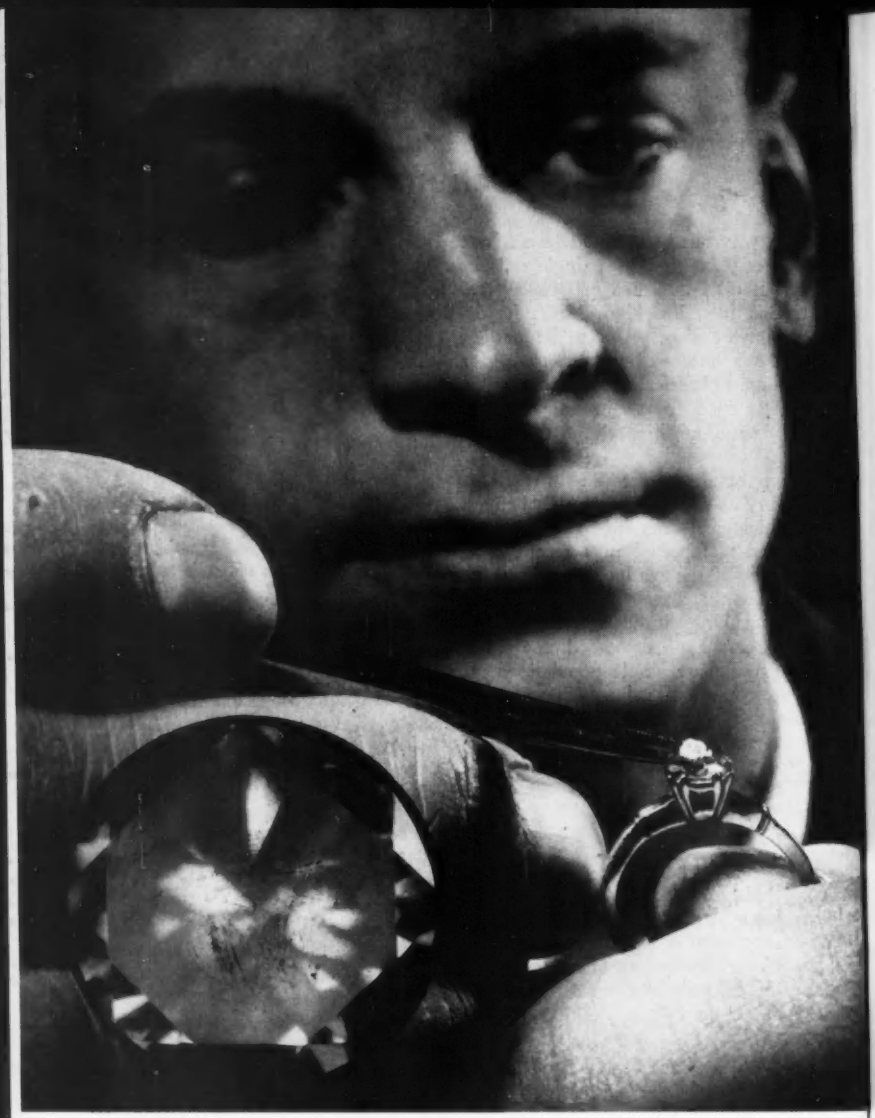
5. It may be possible to grow "a complete individual plant" from a single plant cell.

6. Basic similarities between plants and animals at the cellular level may be found.

The Pfizer scientist grew his single cells from parent tissue isolated in 1951. They were carefully nursed along and, finally, Dr. Nickell found his single, freely suspended pole bean plant cells. He reports that they were of three general shapes: spherical, varying in size; slipper-shaped, and gourd-shaped with one or two necks.

An electronic computer will be employed to determine rapidly the best combinations of raw materials, temperatures, air pressures, air velocities and tank sizes for fermentation processes to make antibiotics.

In Colorado recently "air tankers" dropped water and chemicals on a fire to keep it low until fire fighters could get there by foot trail.



➤ Dr. Robert H. Wentorf, *discoverer of borazon, shows how the new man-made material scratches a gem diamond. Inset: enlarged view of the scratches.*

New Man-Made Material Is Like Diamond in Crystal Structure

Borazon Scratches Diamond

➤ A PHYSICAL chemist has scratched a girl's "best friend."

Dr. Robert H. Wentorf, of General Electric Company, Schenectady, N. Y., has discovered a new material that scratches diamond and stays hard at temperatures where diamond burns up. The material is cubic boron nitride, nicknamed *borazon*.

The discovery was hailed by Dr. C. G. Suits, vice-president and director of research for General Electric, as not the announcement of a product, but "a major scientific achievement, the creation of a new material never observed in nature, with properties equalling or surpassing those of a material long thought to be the 'ultimate.' "

Dr. Wentorf produced the diamond-like crystals of boron nitride by using techniques similar to those employed for producing man-made diamonds. The borazon crystals produced are no bigger than grains of sand and they vary in color: black, deep red, milky white, gray and yellow.

The discoverer said that borazon's hardness is about the same as diamond and "scratches diamond almost exactly as diamond scratches diamond and diamond scratches borazon."

Borazon, however, withstands high temperatures better than its natural rival. Diamond actually burns in air at about 1600 degrees Fahrenheit. Borazon, on the other hand, can withstand temperatures of more than 3500 degrees Fahrenheit.

This resistance to oxidation will make possible superior methods of mounting stones in industrial tools, Dr. Suits said, and may allow bits and wheels to be operated at higher speeds.

Dr. Robert H. Wentorf, discoverer of borazon, explains the properties of the new material by comparing its crystal structure to that of carbon. The element carbon is found in nature in two crystalline forms: *graphite* and *diamond*. Graphite is black, soft and slippery; diamond is a hard, clear crystal. The difference between the two is in the arrangement of the carbon atoms in the crystals.

In graphite, the atoms are tied together in a hexagonal pattern that forms a crystal sheet, but the sheets are only weakly bound to one another. In diamond, the atoms are arranged in a cubic pattern. They are grouped in sheets, but the sheets are tightly bound to each other; this makes the diamond strong and hard.

The compound boron nitride (formula BN) is found in nature in just one form — a white powder that looks and feels like talcum powder. Because it is soft and slippery like graphite, ordinary boron nitride is sometimes nicknamed "white graphite;" and, like graphite, it has hexagonal crystal structure.

"Boron and nitrogen lie on each side of carbon in the periodic table of elements," Dr. Wentorf said, "so that at first sight, you might think that a combination of boron and ni-

trogen might average out to carbon. And in a few ways, they do. . . .

"But," he explained, "there is at least one important difference between graphite and boron nitride. Graphite is black, and it conducts electricity well. Boron nitride is white, and it conducts electricity extremely poorly—it is one of the best electrical insulators known, especially at high temperatures. To a physicist this means that graphite has free or unattached electrons in its crystal — these electrons absorb light and make graphite look black; these same electrons are the carriers of electricity in graphite. But boron nitride has no such free electrons — it is white, and it doesn't conduct electricity.

"Now in diamond there are no extra electrons either — they have been used up to form the strong bonds which distinguish hard diamond from soft graphite."

The analogy between graphite, the hexagonal form of carbon, and hexagonal boron nitride is not complete because hexagonal boron nitride does not appear to have extra electrons that could be used to bind the sheets of atoms firmly together and form a cubic crystal of boron nitride.

When General Electric scientists attempted to make the cubic form of boron nitride, they faced a double deterrent. First, no cubic boron nitride occurred in nature; and second, there were good reasons for believing that it could not be made.

"Trying to make cubic boron nitride," Dr. Wentorf said, "was like trying to catch a new, special kind of fish in a strange lake. You weren't sure whether that lake had any such fish, or whether any lake had such a fish, and the other fishermen were dubious.

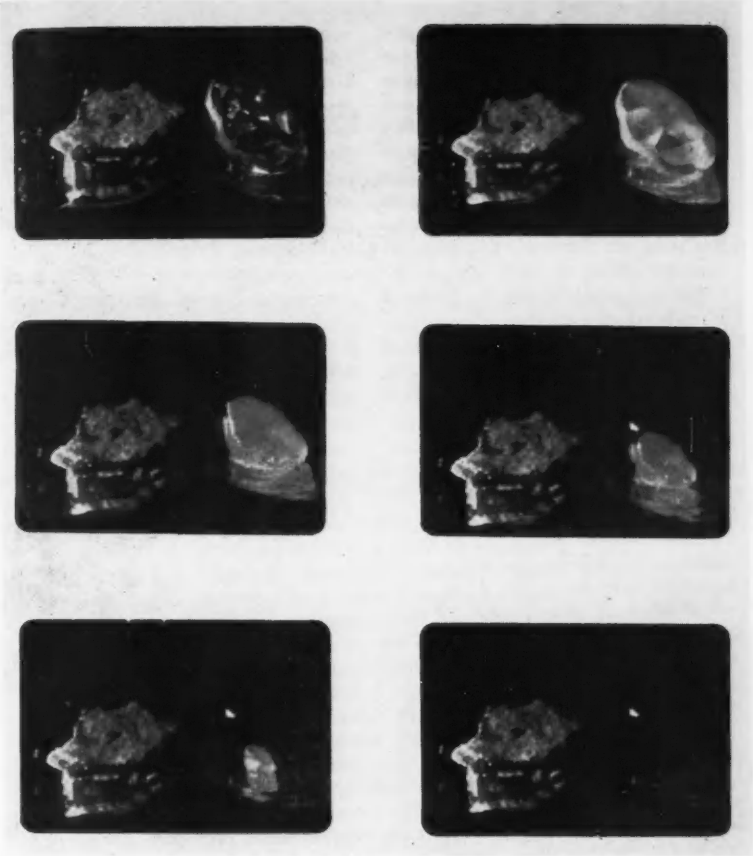
"But our faith was finally rewarded, and we unexpectedly found a way to make the cubic crystal of boron nitride. Evidently, in the crystal each nitrogen atom donates one of its rarely used electrons to a boron atom. The boron atom uses the extra electron to form another chemical bond with a nitrogen atom, and in this way the sheets of atoms are tied together to form a strong crystal, after the manner of diamond."

To avoid confusion between the two forms of boron nitride, Dr. Wentorf nicknamed the new cubic crystal *borazon* — *bor* from boron and *azon* from *azo,* which refers to nitrogen.

A chemical analysis of the borazon crystals produced by General Electric showed that they contained 38.2% boron and 39.6% nitrogen by weight. The theoretical composition of a perfect pure crystal of borazon is 43.6% boron and 56.4% nitrogen by weight.

Borazon is made at a pressure of about 1,000,000 pounds per square inch and a temperature of about 3000 degrees Fahrenheit. It has a density of 3.45 grams per cubic centimeter, which is nearly the same as that of diamond: 3.52 grams per cubic centimeter.

X-ray diffraction patterns of borazon and diamond give further evidence of their similarity, Dr. Wentorf pointed out. The scattering of X-rays from the regular arrays of atoms in a crystal produces arrays of spots that can be recorded on a photographic plate. Each crystal has a characteristic array of spots, by which it can be identified. If two crystals have nearly



➤ A DIAMOND BURNS *but borazon remains unaffected. These photographs, taken at 30-second intervals, show how a small gem stone placed on a resistance heater disappears — burns up — when the temperature exceeds about 1600 degrees Fahrenheit. Borazon, General Electric's new man-made material which is in the same range of hardness as diamond, is not affected. Many other materials withstand temperatures at which diamond burns; the significant part of this demonstration is that borazon combines the hardness of diamond with much greater resistance to oxidation at high temperatures. After the demonstration pictured here, the piece of borazon was used to scratch the face of another diamond.*

the same internal structure, their characteristic X-ray diffraction patterns are nearly the same. Borazon and diamond have very similar X-ray diffraction patterns, which shows that crystals of borazon have a structure similar to diamond. The only differences are that the spacing between the atoms is slightly larger for borazon than for diamond, and that the borazon crystal is made up of two different elements while the diamond is made up of only one.

Because no cubic crystal form of boron nitride exists in nature, borazon is, in one sense, a greater achievement than man-made diamonds, which also were first produced by the General Electric Research Laboratories. In February 1955, General Electric announced that man-made diamonds had been produced from a carbonaceous material subjected to extreme pressures and temperature (1,500,000 pounds per square inch at 5000 degrees Fahrenheit). Industrial diamonds are now in pilot-plant production at General Electric's Carboloy Department, although the cost has not yet been brought below that of natural industrial diamonds now being mined.

On the Back Cover

➤ X-RAY DIFFRACTION *patterns on two separate films show that borazon (left half of picture) and diamond (right half of picture) have closely similar crystal structures. Borazon is the cubic crystal form of boron nitride, recently produced for the first time at General Electric Research Laboratories. The only difference shown is that the spacing between the boron and nitrogen atoms in borazon is slightly larger than the spacing between the carbon atoms in diamond. (When these pictures were made, the X-ray film was wrapped around a cylinder and the crystal placed at the center. X-rays were directed on the crystal through the lower hole shown in the picture. Some X-rays were diffracted by the regular arrays of atoms in the crystal and were recorded on the film as regular arrays of spots merging to form arcs. The rest went through the crystal and produced the bright spot around the upper hole.)*

Rate of Productivity Increase Is Obstacle to Man's Future

Our Productive Potential

by Harrison Brown, *Professor of Geochemistry, California Institute of Technology*

In a paper before The American Association for the Advancement of Science, New York Meeting

➤ Today we are in the middle of a revolution. We are in the middle of a transition from one major level of culture to another — from a culture which is primarily agrarian to one which is primarily urban-industrial. The closest parallel in the past course of human existence was the transition, which took place some 7,000 years ago, from a culture of food-gatherers to a culture of farmers.

During the last 300 years man has achieved a degree of power over his environment which is unprecedented in the thousands of years of human history and in the hundreds of thousands of years of human pre-history. Our rate of material progress and our rate of growth seem to be steadily accelerating, and one cannot help asking: For how long can this acceleration and this growth continue? Will we continue to accelerate? Will we level off? Could it be that, perhaps without realizing it, we are painting ourselves into a corner? Could it even be that we are headed towards catastrophe?

If we are able in the years ahead to avoid catastrophe, it seems reasonably certain that demands for goods will increase rapidly to much higher levels than prevail today. Industrialization has spread thus far to only a small part of the world, and it is destined to become world wide. Within industrial societies themselves, demands for raw materials will increase as the result of increasing population and the need for an ever-more elaborate and complicated technology to cope with the increasing pressures upon the earth's resources.

Suppose that the underdeveloped areas of the world were suddenly to be brought up to a level of consumption which approaches that in the industrial world today. In order to accomplish this, one would have to extract from the earth 18 billion tons of iron, 300 million tons of copper, an equal amount of lead, over 200 million tons of zinc and about 30 million tons of tin, in addition to huge quantities of other metals and non-metals. These totals would be well over 100 times the present world annual rate of production.

Greater Production Possible

The production of such huge quantities of materials would exhaust most of the earth's high-grade reservoirs of metals. But when we view the situation solely from the technological point of view, it is clear that in principle even much larger quantities of materials than these can be extracted from the earth. From the technologi-

cal point of view, our industrial productive potential is limited only by the rate at which we can pour energy into the industrial network. And we know that in the sun's rays, and in the uranium of rocks, we have nearly an infinite quantity of energy available for tapping when we need it. It does not take much imagination to visualize a total world-wide industrial productivity 10, 100 or even 1000 times greater than that of today.

Similarly, our food production potential is much higher than today's productivity. We know that a world-wide extension of the best conventional agricultural practices of today would suffice to feed adequately several times the present world population. By resorting to unconventional techniques, such as the irrigation of vast areas of the world with reclaimed sea water, it is conceivable that as many as 50 billion persons could be supported.

Rate of Increase Limited

Unfortunately, however, although man can in principle provide adequately for a much larger population than exists today, he is confronted by an enormous obstacle — that of the *rate* at which productivity can be increased. We know that industrial production can be increased rapidly. In the U.S., Japan and the U.S.S.R., major industrial production has been doubled every 5 to 10 years for very long periods of time. But even at this rapid rate of increase, decades and generations are required for the average person to notice much improvement in his way of life.

Rapid Population Growth

It is in the area of food productivity, however, where we are confronted with the greatest difficulties. These difficulties stem from the fact that to change agricultural procedures, we must change the attitudes and beliefs of a great many people. And attitudes and beliefs change slowly, over generations rather than over years. In spite of huge efforts in various areas of the world, it has been found difficult to increase food productivity at a rate much faster than about 2 percent per year. When we couple this with the fact that populations can increase at rates which are as high as 3 percent per year, and with the additional fact that the vast majority of the world's peoples are already hungry, the prospects are far from cheery.

Thus, unless it is possible in some way to slow down birth rates, or to speed up the rate of increase of food production far above the best that has thus far been achieved, we are faced with the prospect of watching industrialization spread to areas where people are hungry today and are destined to remain hungry for a long time in the future. Both of these steps involve processes of cultural change and, as such, they are more social and psychological problems and problems of communication than purely technological ones. Unless new techniques are developed in these areas, it would appear that man's future is not destined to be a very comfortable one in spite of the huge productive potential which is at his disposal.

The process of sterilization is enabling housewives in warm climates to buy clean milk, as they would canned goods, off the shelves of stores where there is no refrigeration.

Atoms, Planets, Stars, Universe

➤ THROUGHOUT the vast array of matter, from atoms to the whole universe, new theories and facts are developed in many researches.

First Matter Hydrogen Ions

➤ ALL MATTER first appeared in the universe as hydrogen ions, Dr. Winston H. Bostick, head of Stevens Institute of Technology's physics department, has proposed.

His idea is based on the laboratory creation of miniature "galaxies" that bear a striking resemblance to the giant star systems making up the visible universe. The earth, the other planets and the sun are among the billions of heavenly objects composing one of these galactic systems, the Milky Way.

Laboratory "galaxies" are made by firing chunks of ionized matter at each other at speeds up to 140 miles per second. Dr. Bostick's experiments, reported to The American Nuclear Society, suggested that magnetism is the force repelling galaxies from each other, resulting in the expanding universe that astronomers observe. Dr. Bostick's work was started in June, 1954, at the Radiation Laboratory of the University of California in connection with Project Sherwood, code name for the Atomic Energy Commission's research program aimed at taming the H-bomb's fusion process for peaceful purposes.

After joining the Stevens faculty in 1956, Dr. Bostick developed his galactic theories, in cooperation with Dr. David Finkelstein, also of Stevens.

If further experiments confirm their work, the knowledge of astronomers concerning the origin of the universe may be extended backward by a billion years, which Dr. Bostick estimates is the length of time required for forming a galaxy.

The miniature "galaxies" are formed using a "plasma gun" designed by Dr. Bostick. About the size of a shirt button, the gun consists of two tiny wires embedded in a ceramic base, with the ends flush with the face.

By forcing electric currents up to 10,000 amperes through the wires in one-half of a millionth of a second, an arc is formed between the two wire ends. The wires are made of titanium metal with deuterium gas absorbed or occluded in it. The current heats the tips to temperatures sufficiently high to ionize both the titanium and the deuterium.

Titanium and deuterium ions, particles of matter carrying positive charges, and electrons, tiny negative particles, are hurled from the plasma gun at speeds equivalent to 450,000 miles an hour.

This is the highest speed that matter of such density is known to have attained on earth. Atom smashers produce higher speeds but, by comparison, accelerate only an infinitesimal quantity of particles.

If the energy were expressed as temperature, the titanium ions would

reach 100,000,000 degrees centigrade and the deuterium ions 4,000,000 degrees centigrade. The former temperature is comparable to those generated in thermonuclear explosions or in stars.

When the ionized matter, known as plasma, is fired across a magnetic field, the ions take a curved path and form into tightly knit luminous pellets. Dr. Bostick has named these entities "plasmoids."

The plasmoids behave rather like elementary nuclear particles on a large scale.

When several plasmoids are fired simultaneously toward a center in a magnetic field, they trace spiral paths around the common center.

Sequential photographs of such spirals, created in a split second, have a marked geometric similarity to photographs of heavenly galaxies made by astronomers during various stages of formation and aging.

The speed attained by the plasmoids is approximately that of stars moving around in the spiral arms of galaxies.

He suggests that a heavenly galaxy is formed when the electrons and protons of the ionized hydrogen in space are attracted gravitationally toward a center across a magnetic field. Since this situation is believed unstable, jets of plasma, or ionized matter, would be formed and be attracted toward the center across the magnetic field. When they are, it is anticipated that the centerward-traveling jets will behave like the plasmoids we have produced in the laboratory, that is, produce spiral arms which eventually wrap themselves up into a central structure.

Age and Death for Earth

➤ A NEW AGE for the birth of the earth has been suggested and a prediction that it may be dying has been made by Dr. E. J. Opik of Armagh Observatory, Northern Ireland.

The earth is approximately 3,500,000,000 years old, according to Dr. Opik's calculations published in the annual report of the Smithsonian Institution. The Milky Way galaxy, only one system containing several billion stars among millions of such systems, may be 1,000,000,000 years older.

Both the earth and the Milky Way are relative youngsters, however, when compared to the age Dr. Opik says is the upper limits that can be assigned to the universe itself — 6,000,000,000 years.

The birthday for the universe, the Irish astronomer points out, is the time of the creation of the present star systems or state of matter out of which they are evolved, and does not mean the present configurations.

But the birth of the universe is not the only calculation Dr. Opik has made. He also theorizes that the universe may be "bound for inevitable death." This, he explains, is a possibility. It may be, he reports, that the universe is oscillating, expanding and then contracting, returning to the primitive state of matter.

If this is the case, he states, there may have been many such cosmic structures in the past and may be many more in the future.

The death of the present universe will come about, Dr. Opik thinks, with the eventual return to the highly condensed state of matter, pure nuclear highly condensed particles

such as neutrons, electrons and protons — out of which it evolved.

Then, he says, another universe, but far different from this one, may evolve by the same processes.

To arrive at his conclusions, Dr. Opik combined such factors as the rate at which great star galaxies are pulling away from each other; calculations on the average density of matter in space and the amount of decay of naturally occurring radioactive elements like uranium and thorium.

Origin of Solar System

➤ A NEW THEORY for the origin of the solar system has been proposed by the Nobel Prize winner, Dr. Harold C. Urey of the University of Chicago.

It accounts for some characteristics of meteorites, including the diamonds found in them, and for the varying densities of the planets.

His theory is that objects about the size of asteroids or the moon accumulated in a dust cloud very early in the solar system's history, or about 4,500,000,000 years ago. These solid objects played an important part in the formation of the planetary system and possibly of the sun, Dr. Urey believes.

After clumping together, the solid objects were then heated to temperatures sufficiently high to melt silicates and iron, 1,500 degrees Centigrade. Dr. Urey suggests that either chemical heating by free radical reactions or heating by the fall of objects through gases could produce the necessary high temperatures.

After some period of time, millions or tens of millions of years, during which the objects cooled to about 500 degrees Centigrade, they fell rapidly toward a gravitation center. It was then that the sun was formed, with a gigantic disk composed of leftover gas and these solid objects.

During this process, melting of the iron and silicates that are the chief materials of meteorites could also have occurred.

These primary objects were then broken up by intense collisions that reduced the solid material to fragments varying from too small to be visible up to the size of meteorites, Dr. Urey proposes.

The gas and dust in the giant solar disk were dissipated by solar light pressure and turbulent gases, and some of the solid material was removed by spiraling toward the sun.

It was during this time, about 4,300,000,000 years ago, Dr. Urey believes, that the planets and asteroids accumulated.

During the process of breakup and reaccumulation, separation of the silicates and metals occurred in varying degrees. This variable loss accounts for the different densities of the planets, Dr. Urey reports in the *Astrophysical Journal*.

Fragments resulting from the later breakup of the reaccumulated objects are the meteorites. The primary, or first-formed, solid objects must have clumped together before the formation of the solar system, Dr. Urey believes, in order to account for the known properties of meteorites.

He suggests that protoplanets, or planets in the making, in the sense of large masses of gas and dust of the same composition as the sun did not occur, or at least they did not occur until after the separation of

the metals and silicates in the primary solid objects.

Dr. Urey proposes that the moons circling the earth and other planets were formed by a similar process.

Elements in Cosmic Rays

➤ THE RELATIVE abundance of the elements found in cosmic rays differs from that for matter in the universe, three Australian scientists have reported in *Nature*.

The light elements, they have found, are more than 1,000 times as common in cosmic rays as in the universe. Elements heavier than neon are six times more abundant in cosmic rays.

From these figures, they calculate that this radiation has traveled for a few million years before it smashed into the earth's atmosphere. The scientists who determined the abundances are Drs. J. H. Noon, A. J. Herz and B. J. O'Brien of the F. B. S. Falkiner Nuclear Research and Adolph Basser Computing Laboratories, University of Sydney, Australia.

Their results were obtained from measuring the cosmic rays caught in photographic emulsions flown for about six hours at more than 110,000 feet above Texas in 1956.

The large proportion of elements heavier than neon indicates either that heavy nuclei are more abundant in the source regions of cosmic rays, which are still largely unknown, or that the mechanism by which they attain their great speeds strongly favors the heavy nuclei, or both.

Other scientists have suggested that supernovae, brilliant exploding stars, are a source of cosmic rays that might give the abundances the Australian scientists found. They also discovered definitely that lithium, beryllium and boron are definitely present in the primary radiation.

Most cosmic rays are stopped high in the earth's atmosphere, reacting with atomic nuclei there to form secondary cosmic rays. To detect the primary radiation before it has reacted, scientists must expose their detecting instruments at very high altitudes.

The existence of heavy nuclei in the primary cosmic rays was first established in 1948.

Age of "Young" Rocks

➤ SCIENTISTS can now tell accurately the age of "young" rocks, that is, rocks that are only a million or so years old.

Geologists have not been sure of the age of rocks less than a hundred million years old.

The new accuracy results from new techniques developed by University of California scientists John H. Reynolds, Carniss H. Curtis, Jack F. Evernden and Joseph I. Lipson.

In the past geologists have relied chiefly on the radioactive decay of uranium into lead. This takes a lot of work, it is not as accurate as scientists would like, and it does not work well on younger rocks.

So the Berkeley scientists have developed potassium-argon dating. Potassium (40) decays through radioactivity into argon. Scientists know the rate at which argon accumulates in rocks from this decay.

In their test, the Berkeley group dissolve a rock sample in molten sodium hydroxide. This releases argon, which is collected and measured. By determining how much argon is re-

leased, the scientists can tell how old the rock is.

In addition to providing a measure of age for younger rocks, the technique has other advantages over uranium-lead dating. It is simple, rapid and accurate. Small samples can be used. More rocks can be dated because more of them contain potassium than uranium.

One disadvantage is that the argon leaks out of some minerals, such as feldspar, making their dating difficult.

The method has been used to test several sites in California. Two sites, one million-and-a-half years old, whose ages were fairly well established by other evidence, were accurately measured.

The scientists have also dated formations of granodiorite on the Farallon Islands, off the Golden Gate, at about 90,000,000 years and granitic samples from Yosemite Valley at 80,000,000 to 95,000,000 years.

Glauconite samples from oil well cores are now being tested with the hope that accurate measures of the sequence of the strata can be made. These are formations believed to be in the 10,000,000 to 90,000,000 year range.

Assistance to the principal investigators was given by four graduate students, William Eisenhardt, Peter Wygle, Stanley E. Cebull and Allen Ryall.

Cigarette Smoke Is Complex

▶ JUST A cubic inch of cigarette smoke contains well over 1,000,000,000 particles. These particles are probably made up of hundreds of chemical compounds and gases. Scientists have only scratched the surface of the cigarette's complexity.

These are the findings of a report on cigarette smoke presented at the Southwide Chemical Conference at Memphis, Tenn., by Drs. Marcus E. Hobbs, professor of chemistry, and Pelham Wilder Jr., assistant professor of chemistry, at Duke University.

Research efforts, the chemists pointed out, are complicated by the fact that the composition of smoke is determined by the conditions of smoking, the nature of the tobacco, and the chemical interactions of the many active compounds present.

Cigarette smoke is considered for convenience to be made up of two phases, the gas phase and the particulate phase. The gas phase consists of nitrogen, carbon dioxide and a small amount of carbon monoxide, hydrocarbons, and a wide variety of other substances, including trace quantities of hydrogen cyanide, carbonyl sulfide and methyl chloride. The particulate phase, or cloud of particles, consists of many types of compounds, with individual components running into the hundreds. Only a few compounds of this phase are known at present, such as nicotine, phenols, nicotinic acid, nicotinamide, glutamic acid and glutamide.

One of the key questions still to be answered, Drs. Hobbs and Wilder said, "is one of especial pertinence and interest: To what extent are the smoke components formed in the gas phase and to what extent in the condensed phase?"

Complete Picture of Ore's Origin Promises to Help the Prospector

How Nature Makes Uranium Ore

➤ THE CHEMICAL process that uranium undergoes in its own natural underground laboratory is being unfolded by Dr. Robert M. Garrels of Harvard University. The complete picture of uranium's origin and evolution promises to help the prospector find new deposits of the atomic-age mineral.

Color and a coffee-like percolation are emerging as the key factors in nature's manufacture of uranium ore, Dr. Garrels and scientists of the U. S. Geological Survey and Atomic Energy Commission have found. When uranium ores come in contact with air, their color changes. At depths where there is little or no oxygen, the scientists think, the ores will be grey to blue-black in color. But as the earth's surface wears away and exposes the mineral to the air, the ores turn to the yellow color that every sourdough looks for when prospecting.

The scientists also think that they will be able to predict where uranium is most likely to be found. To reach this end, they are experimenting with many of the naturally occurring uranium compounds such as those found in copper-uranium and vanadium-uranium ores. They have learned that uranium ores dissolve in water best, when they are in the oxidized state.

When combined with vanadium, uranium does not travel in water solutions. When combined with copper and other compounds, however, it does move with ground and stream waters and some of it is eventually carried out to sea. The fact that uranium has a high chemical activity and can be dissolved means that it is widely distributed over the surface of the earth, Dr. Garrels states. The highest concentrations occur in veins and replacement deposits. In unoxidized veins it is found mostly as pitchblende. In oxidized states it is in replacement deposits such as the rich deposits found in the Colorado Plateau.

Geologists believe that the uranium now being mined in the Colorado Plateau, richest in the United States, was formed in nature's underground laboratory in the following way:

1. The uranium was dissolved by ground water.

2. The ground water carried the dissolved uranium through rocks deep in the earth.

3. As it traveled through the earth, it came in contact with reducing agents such as fossil logs, leaves or twigs. This reaction precipitated the uranium.

4. When the uranium was then exposed to the air by erosion of the overlying rocks, it became oxidized and turned yellow.

For The Home Lab

The Story of Calcium

I. The Metal

by Burton L. Hawk

➤ Calcium is the third most abundant metal, and we certainly need not stress its importance to mankind. If all of the calcium were suddenly withdrawn from the earth you can well imagine what would happen to the thousands of buildings, bridges, dams, highways, and similar structures. For calcium is the "builder" element. Consider such calcium compounds as limestone and marble, along with cement, concrete, plaster and mortar. Calcium even plays an important part in the structure of bone in animals.

Ordinary lime has been used for centuries although the alchemists had no idea of its composition. Because they could not decompose it, they listed it as an element. And so it was considered for many years until the chemist Lavoisier put forth his theory that it must be an oxide of an unknown element. But still no one was successful in decomposing the compound.

It remained for none other than the famous Sir Humphry Davy to accomplish the difficult reduction and obtain the metal. Still triumphant over his brilliant isolation of sodium and potassium, he next decided to attempt the isolation of calcium in a similar manner. Thus he attempted the reduction of calcium hydroxide (as he had potassium hydroxide) with the electric current. But the alkaline earth metals are not so easily obtained and he was unable to break down the compound.

For the second plan of attack he tried to reduce calcium compounds by using metallic potassium. Although there was definitely some reaction, he was unsuccessful in obtaining any metallic calcium.

Next he tried dissolving the lime, which was apparently not a conductor, in molten potash which he hoped would act as an electrolyte. When he passed an electric current through this mixture he obtained some metallic globules but they immediately burst into flame and he could collect nothing but the original lime and potash.

Naturally, these failures must have been disappointing, but Sir Humphry was not the type to accept defeat. Next he tried a different attack. He would try to obtain calcium amalgam and then distil off the mercury to leave the pure calcium metal. This he did by reacting mercuric oxide with lime but he could not prepare sufficient amalgam to isolate the metal.

While wondering what to do next, Davy happened upon an article by another brilliant chemist of that day, Jons Jakob Berzelius. Berzelius reported that he had prepared calcium amalgam by mixing lime with mercury and electrolyzing. Using this report as a basis for his idea, Davy mixed lime with mercuric oxide and placed the mixture on a metal plate which was connected to the positive

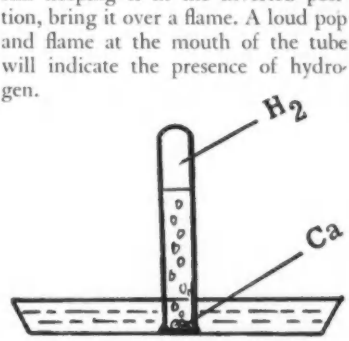
pole of his battery. He used metallic mercury as the negative in the center of his mixture. With this arrangement he obtained a sufficient quantity of calcium amalgam. He then distilled off the mercury and looked upon the silvery calcium metal for the first time. After so many discouraging failures, this moment must have been one of supreme joy and excitement for Davy. He then went on, and using similar methods, was able to isolate for the first time: barium, strontium and magnesium.

Today calcium is prepared by electrolyzing the fused chloride. The metal does not have a wide-spread use, but it is available readily. You should not have any difficulty in purchasing a small quantity from a chemical supply house for less than a dollar. If you intend to keep the metal, it it best preserved under light oil.

Cut a small piece of the metal and note its shiny luster. Also note how quickly it tarnishes in the air. It is rather hard and you may have some difficulty in cutting it. You might try using a pliers. It might also be a good idea to wrap the metal in a cloth before attempting to cut it with a pliers.

Place a *small* piece (no larger than a pea!) of the metal in a shallow pan of water. Note the bubbles of hydrogen as the metal decomposes the water. For a more interesting effect, add a few drops of phenolphthalein solution to the water, then drop in a piece of calcium. As the calcium dissolves, the water turns pink.

Fill a test tube with water. While holding your thumb over the mouth, invert the tube and slide it underneath the water in the pan and directly on top of the calcium. The hydrogen will rapidly replace the water in the tube. When the tube is empty, remove it with a holder and still keeping it in the inverted position, bring it over a flame. A loud pop and flame at the mouth of the tube will indicate the presence of hydrogen.



For a more impressive demonstration, ignite a match and, with pliers or tongs, hold the flame directly over the bubbles as they rise out of the water from the calcium. As each bubble hits the flame, a miniature explosion will occur. When the bubbles arise in rapid succession, you will have a "machine-gun" effect.

Calcium reacts vigorously with acids. Drop a small piece in a dilute solution of hydrochloric acid. Note the action is more vigorous than with water. A solution of calcium chloride is obtained. Drop a piece of the metal in concentrated sulfuric acid. Here the reaction is very slow. Now drop a piece in dilute sulfuric acid. The action is much more lively. Note the white powder which is formed. This is calcium sulfate, which is insoluble in water.

Calcium burns in the air with a brilliant white flame forming the oxide and the nitride. If you have

difficulty in igniting the metal by holding it in a flame, we suggest you try using a blowpipe. Place a *small* piece of the metal in a porcelain crucible lid. Grasp the handle of the lid with tongs and direct the blowpipe flame directly upon the metal. Keep your face away! After the metal burns allow the residue to cool thoroughly. Then add a few drops of water. Smell cautiously. Can you recognize the odor of ammonia? This is due to the decomposition of the nitride.

Calcium is an active reducing agent. You can demonstrate this characteristic by mixing several rice-grain-size pieces of the clean metal with one or two grams of iron oxide. Place the mixture in a porcelain crucible, with lid, and apply heat, gradually at first. Again, keep your face away! The reaction may be vigorous so be sure you use small quantities. When no further reaction occurs, allow the crucible to cool *thoroughly*. Then remove lid. Dump contents out and look for small pinheads of metallic iron. A magnet will be helpful in locating the metal.

Although calcium is not dangerous to handle, you will be wise to exercise caution. Remember not to handle the wet metal with your bare hands. Also be sure every piece is accounted for so that there will be no danger of fire from hydrogen expelled.

"Squeezing Water" Stops Jet Plane

➤ HIGH SPEED jet planes can be stopped quickly on short runway airfields equipped with a "water squeezer."

The relatively simple device has stopped a landing Marine Corps jet fighter in less than 100 yards without damage to the airplane or arresting gear.

The "water squeezer" is an energy absorber developed by All-American Engineering Company, Wilmington, Del., under a U.S. Navy Bureau of Aeronautics contract. It is expected to be ready for military service in the near future.

The new method works like this: The landing aircraft engages, with a hook, one of two cables stretched across the runway. The cable is attached to a piston in a water-filled pipe. As the engaged airplane rolls forward, it pulls the piston through the water, absorbing the plane's energy of motion.

The device is known as the expeditionary arresting gear because it can be dismantled easily, packed into helicopters or cargo aircraft, then set up at fields with runways as short as 1,000 feet. making such strips suitable for landing jet fighters.

No adjustment of the device is necessary for different landing weights and speeds.

A "water squeezer" is also used at the U.S. Air Force test base at Hurricane Mesa, Utah, where a high-speed sled is stopped short on a track to test pilot ejection seats for airplanes.

The All-American Engineering Company is now experimenting with arresting gear based on the same principle to be used as safety barriers at commercial or military airports.

See Hope for Medical Use For Pituitary Hormone from Cattle

Human Pituitary Hormone Isolated

➤ HUMAN and monkey pituitary growth hormone have been isolated for the first time, stimulating renewed hope that this important secretion eventually may be available for the treatment of human disease. The achievement was reported to the American Cancer Society by Dr. C. H. Li, director of the University of California Hormone Research Laboratory.

The human and monkey hormone molecules appear to be similar and both are markedly different from the growth factor of cattle, which provides the foundation of knowledge accumulated in 35 years of work on this hormone.

Dr. Li suggested that the big difference may explain why the cattle growth hormone, although it readily stimulates growth in rats, has not been consistently effective in humans.

The scientist reported that monkey and human growth hormones appear to be about half the size of the cattle hormone (a molecular weight of about 27,000 against 46,000), with about 240 amino acids instead of the 400 in the cattle factor.

Also the cattle hormone molecule has a cumbersome Y structure (with two N-terminals and one C-terminal amino acids), while the human and monkey hormones have the much simpler straight-chain amino acid structures (with a single terminal amino acid phenylalanine on each end).

The scientist said the monkey hormone is now being tested at the National Cancer Institute to see whether it works in man. Efforts to use the cattle hormone in humans to treat dwarfism have not been successful.

Dr. Li said the biological activities of the large hormones may lie in "cores" of the hormone molecules. The "core" that stimulates growth in the human, monkey and cattle hormone may be a small molecular segment that is identical in each hormone. The rat may be capable of degrading the cattle hormone and using the "core," while man may not have this ability.

The scientist said human and monkey hormone had been tested in rats, and found to be equally effective as cattle hormone. In view of the difference in size of the hormones, this would seem to support the "core" idea.

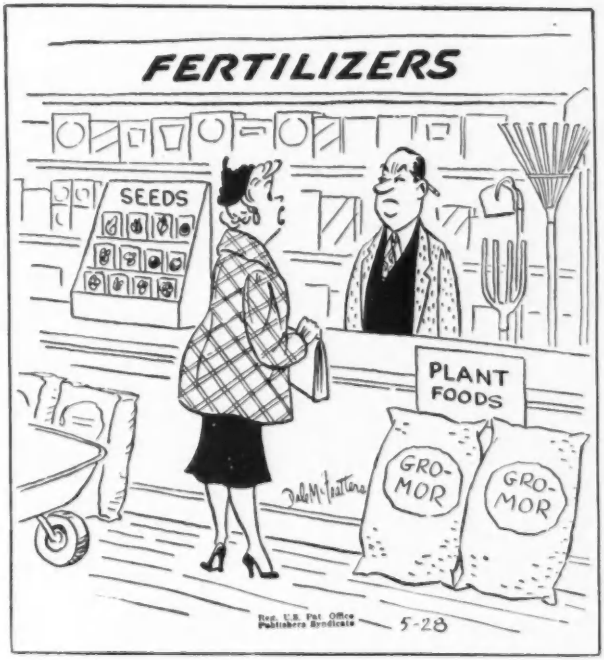
Dr. Li said the new research was made possible by the recent development of polio vaccine and of surgical operations to remove the human pituitary. Eli Lilly & Co., a maker of polio vaccine, supplied pituitaries from monkeys used in making the vaccine. Drs. Rolf Luft and Herbert Olivecrona of the Karolinsk Institut, Stockholm, Sweden, pioneers in the human pituitary operation, provided a dozen human glands for the extraction of human hormone.

From the human glands only a minute amount of hormone was ob-

tained, 29 milligrams in the form of a white powder. There was just enough to test its activity in rats and obtain its molecular weight and something about its structure.

Future work depends upon getting larger quantities of human and monkey glands. The scientist wants to determine for certain whether monkey and human growth hormone are identical. After that, the job would be to learn how to degrade cattle hormone and obtain the active "core" which then might be active in man.

There is little possibility that enough monkey hormone could ever be obtained for widespread use in treatment of disease, but the cattle hormone could be obtained in fairly large quantities.



➤ *"I forget the name, but it's 47% of one thing, 33% of another and 20% of something else!"*

New Anti-Ulcer Drug Lets Patient Eat What He Wants

New Drugs and New Uses

➤ A POSSIBLE new anti-ulcer drug, that lets ulcer patients eat what they want, was introduced to American doctors at the first annual Clinical Conference on Peptic Ulcer Therapy in New York.

The new drug, trade-named Exul, is already in use in Denmark, Italy and Canada, and is just now being made available to U. S. doctors on a prescription basis.

The basic ingredient of the new drug is a substance called Nupra, discovered over 20 years ago in research on vitamin K. Nupra is extracted from the liver, brain and adrenals of cattle by certain organic solvents.

Reporting on his use of the drug on human ulcer patients over a two and a half year period, Dr. Ejner Jarlov, dean of medicine at the University of Copenhagen, said he had effective results in 30 out of 47 patients. All of these were able to continue working and had no restrictions put on their diet.

Describing the action of the new drug, Dr. Carl W. Ebeling, chief of the gastroenterology department, University of Maryland Medical School, said that it was able to keep working even when there was a high acid content in the stomach. Dr. Jarlov reported that the drug eliminates ulcer symptoms. He hopes that use of the drug will help determine the nature of ulcers.

Exul is being made in Denmark and distributed in this country by Yorktown Products Corporation, New York City.

Lowers Blood Pressure

➤ ANOTHER drug to combat high blood pressure, and said to offer advantages over older drugs, was announced by Dr. Karl J. Brunings, director of chemical research for Chas. Pfizer & Co., Inc., Brooklyn, N. Y.

The new drug, trade-named "Moderil," reduces blood pressure by cutting communications between selected nerve centers and the arteries they serve. It is extracted from the Indian snake root, Rauwolfia, source of many of today's tranquilizing drugs. The new drug seems to control anxiety and tension as well as high blood pressure, Dr. Brunings said. This relief of anxiety often associated with high blood pressure is believed to be an added advantage of the drug. "It has been given to hundreds of patients with hypertension and anxiety and has been found to be highly effective," he said.

Tropical Dysentery

➤ FOR ANY major war in tropical countries, such as now threatens in Egypt, scientists have a new medical weapon. The weapon is one of the newer antibiotics, puromycin. It can suppress and prevent infections by several types of intestinal parasites such as those causing amebic dysentery.

Preliminary trials by Drs. Martin D. Young and Geoffrey M. Jeffery of the National Institute of Allergy and Infectious Diseases, stationed at Columbia, S. C., and Dr. Joe E. Freed of the South Carolina State Hospital at Columbia, were reported to the American Society of Tropical Medicine and Hygiene.

Modern drugs have not been as effective against the protozoan parasites as against bacteria. Recently, however, puromycin was shown to remove protozoa from the intestines when given as a treatment. The question remained whether it would also be effective as a suppressive or preventive medicine.

Patients with various intestinal parasites representing naturally occurring infections participated in the research. In a typical study involving all patients on one ward, 16 of these inmates did not receive puromycin and served as controls, while 37 other patients were given treatment doses of the drug for four days. Nineteen of these were then put on a six-week suppressive regime, and received half the dose three times each week for six weeks, while 18 were given only the initial treatment dosage.

At the end of six weeks, those receiving the suppressive drug had no protozoa, while those not receiving the suppressive had acquired three infections. In patients receiving no puromycin, seven of 21 original protozoal infections were lost but 16 new ones were gained, showing that transmission of infection was occurring among those patients, although suppressive doses of the drug protected their associates.

Ileitis

➤ VANCOMYCIN, a powerful new antibiotic, has proven effective against intestinal infections usually found in ileitis. It is an antibiotic coming from the same type of soil bacteria that produce the famous streptomycin and Terramycin.

The antibiotic can be given either by mouth or intravenously and travels quickly to the lung, heart and intestinal cavities, stamping out all existing micrococcal infections.

Vancomycin's most valuable characteristic is that bacteria cannot build up resistance to it as fast as they can to other antibiotics. It causes no toxic reaction in most people and also shows no cross resistance with other antibiotics that may be given along with it.

Successful use of the new antibiotic was reported by Drs. Joseph E. Geraci, Fordyce R. Heilman, Donald R. Nichols, William E. Wellman and Griff T. Ross of the Mayo Foundation.

Heart Disease

➤ TESTS ON patients with a new drug that may lead to a way of stemming heart disease have begun at the National Heart Institute, Dr. Daniel Steinberg told the annual convention of the Association of Military Surgeons of the U. S.

The drug slows down the body's production of cholesterol, a substance thought to be involved in serious artery and heart disease.

The body's production of this substance accounts for about two-thirds of the total amount found in the blood. The other third is taken in by eating cholesterol-containing foods.

Past methods of control have centered around dieting, but if this new inhibiting drug works, heart patients will be able to eat everything they want, without worrying about the cholesterol found in fatty foods.

The drug, called delta-4-cholestinenone, had been tried before on animals, but in the usual dosage had produced dangerous side effects on the adrenal glands.

By cutting the dosage almost in half, Dr. Steinberg has avoided all the bad side effects of the drug and still retained its powerful action against cholesterol production.

So far all experiments have been done on animals and have dramatically reduced the cholesterol level 20% to 40% over an eight-month period.

Pilot studies are now beginning on several human patients at the Clinical Center of the National Institutes of Health. They will be watched very carefully for any toxic reactions. Dr. Steinberg believes it will be at least six months before any definite proof of the drug's value can be established. He hopes to find that this drug, or one like it, will completely control the blood's cholesterol level and thus perhaps help free mankind from one of its greatest killers.

Quick Pain Relief

➤ SWIFT RELIEF of pain with few side effects can be obtained with a new drug, dipipanone, three physicians report in a recent *British Medical Journal*.

Chemically, the drug is related to methadone, one of the relatively new pain relievers. When injected under the skin, dipipanone started to relieve pain within 10 minutes and its effect reached its maximum in 20 minutes. Pain was then relieved for about five to six hours.

The drug was given to 100 patients suffering from medical conditions such as pleurisy, coronary thrombosis, cancer, ulcers, sciatica and gallbladder attacks. It was also given to 100 women after gynecological operations. For these it was considered more effective than any other pain-relievers, including morphine in one-sixth grain dosage. The drug gave complete relief of pain in 95 out of the 100 women after operation and in 67 of the 100 medical patients, with moderate relief in another 27 of these.

While no withdrawal symptoms were seen after up to 80 effective pain-relieving doses, no conclusion can be drawn about the possibility of addiction to the drug because in most of the cases the pain was short-lived and did not require prolonged use of the drug.

Doctors reporting the new drug are R. O. Gillhespy and E. Cope of the Dudley Road Hospital, Birmingham, and P. O. Jones of the Wellcome Foundation, Ltd. The drug has been trade named Pipadone by its manufacturer, Burroughs Wellcome and Co.

Cuts Arthritis Injections

➤ GOOD RESULTS with a new, long-acting form of ACTH for patients with rheumatoid arthritis and other collagen diseases were reported by Drs. Harry E. Banghart and Richard K. D. Watanabe of Philadelphia at a meeting of the Southern Medical Association.

The big advantage of the new preparation is that it is long-acting

and patients need not have injections every six hours or even twice a day. The new preparation need not be given oftener than once in 24 hours, and four patients got along with one dose once a week. Two patients did all right on one dose every two days.

The new preparation combines ACTH, the famous antiarthritis pituitary hormone, with zinc hydroxide. Besides its long-lasting action, it is easier to give, and patients can even give it to themselves.

Of 22 patients with rheumatoid arthritis that had not been helped by cortisone, hydrocortisone, gold salts or other treatment, 18 were helped by the ACTH zinc hydroxide preparation. Seven of eight patients with lupus erythematosus, an ailment with fever, skin inflammation and other symptoms, were helped by the new preparation, as were some other patients with skin and connective tissue ailments.

New Arthritis Drugs

➤ Two NEW drugs, claimed to be more effective against arthritis than any now used, were announced at a recent American Rheumatism Association meeting.

Medrol, one of the anti-arthritic drugs, is a new hormone that chemically resembles cortisone and hydrocortisone but has 12 to 18 times the potency and "lacking the chief side effects" of the older drugs, Dr. E. Myles Glenn of the Upjohn Company, Kalamazoo, Mich., who developed the drug, reported. Up to now, all results have been on experimental animals, however, and as yet there are no reports on Medrol's effectiveness on humans. Medrol, Dr. Glenn said, was tailor-made to remove the chief defect of older arthritis drugs, that of causing too much salt and water to be held in the body.

The other new drug, reported by researchers from the Sloan-Kettering Institute for Cancer Research, New York, and the Hospital for Special Surgery, New York, has already been tried on a group of 18 arthritic patients for periods ranging from five months to a few weeks. So far, the new hormone, known as triamcinolone, has produced no serious side effects and all the arthritic patients treated have responded well. Within 72 hours, they all lost from four to eight pounds and the characteristic swelling of the tissues subsided.

The investigators emphasized that not enough time has elapsed and too few patients have been treated to know whether more prolonged use of triamcinolone will create any bad effects. But, they said, its demonstrated potency and the fact that no bad side effects have yet been seen suggests that it should get a large scale trial.

This new compound is not yet on the market but will be distributed by Lederle Laboratories sometime in the future.

Those reporting on this drug were Drs. Leon Hellman, B. Zumoff, M. K. Schwartz, T. F. Gallagher, Carl A. Berntsen and Richard H. Freyberg.

Checks Pregnancy Nausea

➤ EXPECTANT mothers can get relief from the nausea and vomiting, or morning sickness, of early pregnancy through the latest tranquilizing drug to be introduced to the medical profession.

XUM

The drug is a chemical relative of chlorpromazine, now widely used in mental illness. For mild or moderate emotional problems the new drug promises to be a good relaxer or tranquilizer. But its chief value is expected to come through its quick antivomiting effect not only in pregnancy but in virus stomach and intestinal disorders, after operations and radiation treatment, in terminal cancer and other conditions.

The drug is called Compazine by its U. S. manufacturer, Smith, Kline and French, Philadelphia.

Measure Unconscious Drives

➤ CHLORPROMAZINE and reserpine, two well known tranquilizing drugs, may make it possible to measure a person's "psychic energy," it was reported to the American Psychoanalytic Association meeting in New York.

The two drugs reduce the symptoms of mental illness by weakening unconscious drives which would otherwise break through repressive forces holding them back, reported Drs. Mortimer Ostow, Albert Einstein College of Medicine, New York, and Nathan S. Kline, Rockland State Mental Hospital, Orangeburg, N. Y.

If this is true, they said, it may ultimately make possible the measurement of a mental force which has existed only in theory up to now.

Probable source of this psychic energy, is the brain's basal ganglia, a group of structures at the base of the brain, they reported. The tranquilizing drugs seem to affect the globus pallidus, the most primitive of these structures, they said.

The two tranquilizers have made psychoanalysis possible with patients who would have otherwise been too disturbed to treat.

Tranquilizer and P-32 n Pharmacopeia

➤ AN ATOMIC age chemical, sodium radiophosphate, containing P-32, and one of the modern tranquilizing drugs, chlorpromazine, are going into the U.S. Pharmacopeia through a supplement to the U.S.P. XV.

The Pharmacopeia is a book which provides the standards for the most important medicines used in the United States and many Latin American countries. Its standards are enforced by the U.S. Food and Drug Administration and by many state and municipal health agencies. The Pharmacopeia was established in 1820 and is revised every five years by a national voluntary committee of medical and pharmaceutical experts.

The first supplement to the Fifteenth Revision was published Aug. 20, and all changes and additions given in this supplement were effective as of Sept. 1, 1956.

This first supplement was scheduled for earlier publication but was held with the hope of including another famous tranquilizing drug, reserpine. But even with the delay in publication, the reserpine material could not be got ready because of difficulties with respect to assay. It is hoped now that reserpine will be able to get official U.S.P. standing before the end of 1956.

New Chemical Patents

To obtain copies of these new patents, order them by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents in coin, money order or Patent Office Coupons (but not stamps) for each patent ordered.

Improve Qualities of Wood

➤ A WAY to improve on the natural qualities of wood has been found.

The wood to be treated is impregnated with a chemical solution and then dried. The resulting product has its hardness, weather- and fireproofing, liability to swell and compressive strength improved. It does not lose its elasticity.

The invention of a German scientific team, the wood can also be colored during the chemical processing. Its inventors, Hans Krzikalla of Heidelberg and Oskar Lissner of Mannheim, claim that it will prove useful in architecture, the furniture industry and wherever wood that is both hard and elastic is needed.

The chemical used is an aqueous ammoniacal solution of an adduct from colophony and an aliphatic unsaturated carboxylic acid containing from three to four carbon atoms. In tests on spruce, the treated wood had an increase of 43% in weight; 51% in compressive strength; 63% in hardness; 21% in bending strength; and a decrease of 59% in hygroscopicity and 42% in tendency to swell. Awarded patent No. 2,768,910, the inventors assigned the patent rights to Badische Anilin- & Soda-Fabrik Aktiengesellschaft, Ludwigshaven, Germany.

Grain Storage

➤ A METHOD for storing surplus grain products by coating them with a waterproof material won patent No. 2,768,896 for its inventor, Fred F. Lewis of Brady, Mont. Mr. Lewis protects loose kernels piled on the ground by spraying a nontoxic thermoplastic flexible resin such as polyethylene over the grain. The plastic adheres to the kernels, forms a coating and protects the edibles from deterioration due to weather, rooting or depredation.

Home Pasteurizer

➤ A CITY man has invented a portable home milk pasteurizer for people living on the farm.

Oscar C. Hoggren of Chicago, Ill., received patent No. 2,769,564 for the pasteurizer, which he claims meets the exacting requirements for pasteurization set by the U.S. Public Health Service. The device heats the milk to above 160 degrees Fahrenheit and holds it at that temperature for 15 minutes. The inventor says that the home pasteurizer can be taken apart easily and sterilized.

The pasteurizer is equipped with an automatic controlling device that functions at the end of the heating

cycle, thereby preventing the milk from acquiring a bad taste from overheating. The device also protects the light- and oxygen-sensitive vitamins in the milk being treated.

New Sandpaper

➤ A NEW TYPE of sandpaper and a new technique for applying it has been invented by John F. Twombly of Aiken, S. C. The sandpaper, Mr. Twombly says, resists gumming and clogging. It is made of a stearate of zinc or other metal in an amount ranging from 0.1 to 50 milligrams per square inch of abrasive surface. Granted patent No. 2,768,886, the inventor assigned the patent rights to the Norton Company of Worcester, Mass.

Water-Repellent Fabrics

➤ BOTH natural and synthetic fabrics can now be made water-repellent so they will not be spotted by rain, weakened or shrunk by washing in water or lose their shape on exposure to high relative humidities.

The invention that makes this possible earned patent No. 2,769,732 for its inventor, Thomas Boyd of Springfield, Mass.

Water-repellency is attained on fabrics by depositing polymers and copolymers of titanium organic derivatives or copolymers of the titanium organic derivitives with silicon organic derivatives on natural and synthetic fabrics.

Mr. Boyd lists several examples of tests on cotton muslin, woolen flannel, linen, nylon and cellulose acetate rayon. A strip of wool flannel, for example, dipped in a one percent solution of a polymeric stearyl orthotitanate in anhydrous solvent naphtha, held its water-repellency after repeated launderings and dry cleanings. Mr. Boyd assigned the patent rights to the Monsanto Chemical Company of St. Louis, Mo.

Castor Oil Rubber

➤ A BY-PRODUCT formed in the making of castor oil is an integral part of a new rubber, designed to keep tires rolling in the coldest weather. The rubber, called "Arctic rubber," is designed to keep from stiffening or becoming brittle in temperatures ot 50 degrees below zero centigrade or lower.

The cold weather rubber is the development of Jean Paul Ferrin of Akron, Ohio. The rubber, Mr. Ferrin points out, is made by adding large amounts of plasticizers or extenders to high-Mooney rubber.

As a plasticizer, Mr. Ferrin uses a left-over from the manufacture of castor oil, aliphatic alcohol esters of the saturated, long chain polybasic acids. This, together with a tough, high-computed-Mooney rubber, produces a rubber compound with good physical characteristics and flexibility and nerve maintained at extremely low temperatures. It is particularly suited, Mr. Ferrin adds, for use in the far northern climates.

Mr. Ferrin was awarded patent No. 2,776,693 for his cold weather rubber and assigned the patent rights to the General Tire and Rubber Company of Akron, Ohio.

High Strength Ceramics

➤ A CERAMIC that withstands thermal shock at temperatures of 1,700 degrees Fahrenheit and higher has been made from aluminum titanite.

The ceramic, in addition to its high thermal shock resistance, is also capable of sustaining sudden temperature changes without physically being ruptured. In addition, it can be reheated.

Invented by Cameron G. Harman of Worthington and John W. Lennon of Columbus, Ohio, the ceramic composition has many industrial uses. As explained by the inventors, usually compositions with a high coefficient of linear expansion meet a sudden temperature change and crack, such as "when a hot piece of ordinary glass is plunged into cold water."

To overcome this, the inventors use aluminum titanite, which has a low coefficient of expansion, and discovered a means to stabilize the compound. In tests, the ceramic held up well after 300 hours at a temperature of 2,200 degrees Fahrenheit. The inventors earned patent No. 2,776,896 and assigned the patent rights to the Cambridge Tile Manufacturing Company of Cincinnati, Ohio.

Synthetic Coconut Beverage

➤ ELISEO LUQUE of Naguabo, Puerto Rico, has developed a synthetic coconut water to be sold as a beverage. To make it, Mr. Luque takes the coconut oil from fresh coconut meats and mixes it with alcohol and water. The extract is then diluted and carbonated and served up as a hot-weather drink. The Puerto Rican inventor was granted patent No. 2,776,891.

Instant Drying Photostat

➤ A GOVERNMENT SCIENTIST, conscious of the need to save the taxpayer's time and money, has invented an on-the-spot photostat process. With the instant drying photostatic method, invented by Max H. Goldschein of Washington, D. C., an employee can make a photographic copy of a drawing or document for immediate use under conditions where it is inconvenient or impossible to remove the original to a photographic establishment.

Key to quick photostat is the use of a translucent or semi-opaque, water-resistant sheet, one side of which is sensitive to light and the other side of which is tinted to retard the passage of actinic rays.

In operation, when a copy of a document is to be made and it is printed on one side only, the light-sensitive material is placed in the exposure device with the light-sensitive emulsion side up. The document is placed face up on top of the sheet. The material is then exposed to ordinary daylight or a light bulb. After proper exposure, the material is rolled into a cylinder and dropped in developing, fixing and washing bottles and dried. A document printed on both sides can also be copied. Mr. Goldschein received patent No. 2,773,769.

Rainproof Fabric

➤ A RAINPROOF fabric that is breathable, developed by Boutwell H. Foster of Maplewood, N.J., was granted patent No. 2,771,661. Air and moisture vapor pass through it readily, he claims, because the water-impervious coating is so applied as to leave uncoated areas protected by coated ones, in a fashion somewhat resembling rounded Venetian blinds. Mr. Foster assigned his rights to the United States Rubber Company, New York.

Book Condensations

SEPARATION AND PURIFICATION — Arnold Weissberger, Ed. — *Interscience,* Volume III, Part I of Technique of Organic Chemistry, Rev. ed., 873 p., illus., $17.50. Much of the success of the organic chemists depends upon a wise selection and skillful application of the methods discussed in this work.

THE CHEMISTRY AND TECHNOLOGY OF LEATHER — Volume 1, Preparation for Tannage — Fred O'Flaherty, William T. Roddy and Rovert M. Lollar — *Reinhold,* 495 p., illus., $14.00. The making of leather is generally conceded to have been the first manufacturing process of man.

HOW TO APPLY AND SINTER FLUOROCARBON COATINGS: Gene Bartczak— *Gene Bartczak Associates.* 12 p., illus., paper, 50 cents. Describing use of this method to avoid sticking and corrosion and for other purposes.

MOMENTUM TRANSFER IN FLUIDS — Wm. H. Corcoran, J. B. Opfell and B. H. Sage — *Academic Press,* 394 p., illus., $9.00. Covering the area of fluid mechanics relating to laminar and turbulent shear-flow, boundary-layer analysis and statistical treatment of turbulence which is of special interest to chemical engineers.

OUT OF THE TEST TUBE — The Story of Chemistry — Harry N. Holmes — *Emerson Books,* 5th ed., 313 p., illus., $4.50. This edition has been completely revised and contains much new material including sections on atomic power, atom bombs and hydrogen bombs.

MODERN MIRACLES OF THE LABORATORY — Frank Ross, Jr. — *Lothrop, Lee & Shepard,* 224 p., illus., $3.00. Telling in simple language the great part chemistry has played in man's relationship to the material world around him from the days of the ancient alchemists to our present-day chemists.

ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY: Volume 15, Waxes to Zymosterol and index to volumes 1-15 — Raymond E. Kirk and Donald F. Othmer, Eds. —*Interscience.* 936 p., illus., $30.00. Clear descriptions of the processes used in industry or home to produce various chemical products.

THE ENCYCLOPEDIA OF CHEMISTRY — George L. Clark, Ed. in chief — *Reinhold,* 1037 p., illus., $19.50. A single integrated volume of reference in which the contributions of hundreds of authorities provide data for the chemist, engineer and student.

QUANTUM CHEMISTRY: An introduction — Walter Kauzmann — *Academic.* 744 p., illus., $12.00. More space than usual is devoted to discussions of the nature and seriousness of the mathematical approximations one needs to use in solving many quantum chemical problems.

ADVANCES IN CARBOHYDRATE CHEMISTRY — Vol. 11 — Melville L. Wolfrom and R. Stuart Tipson, Eds. — *Academic Press,* 465 p., illus., $11.00. Included in this volume is a generalized cumulative index to Volumes 1-10.

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